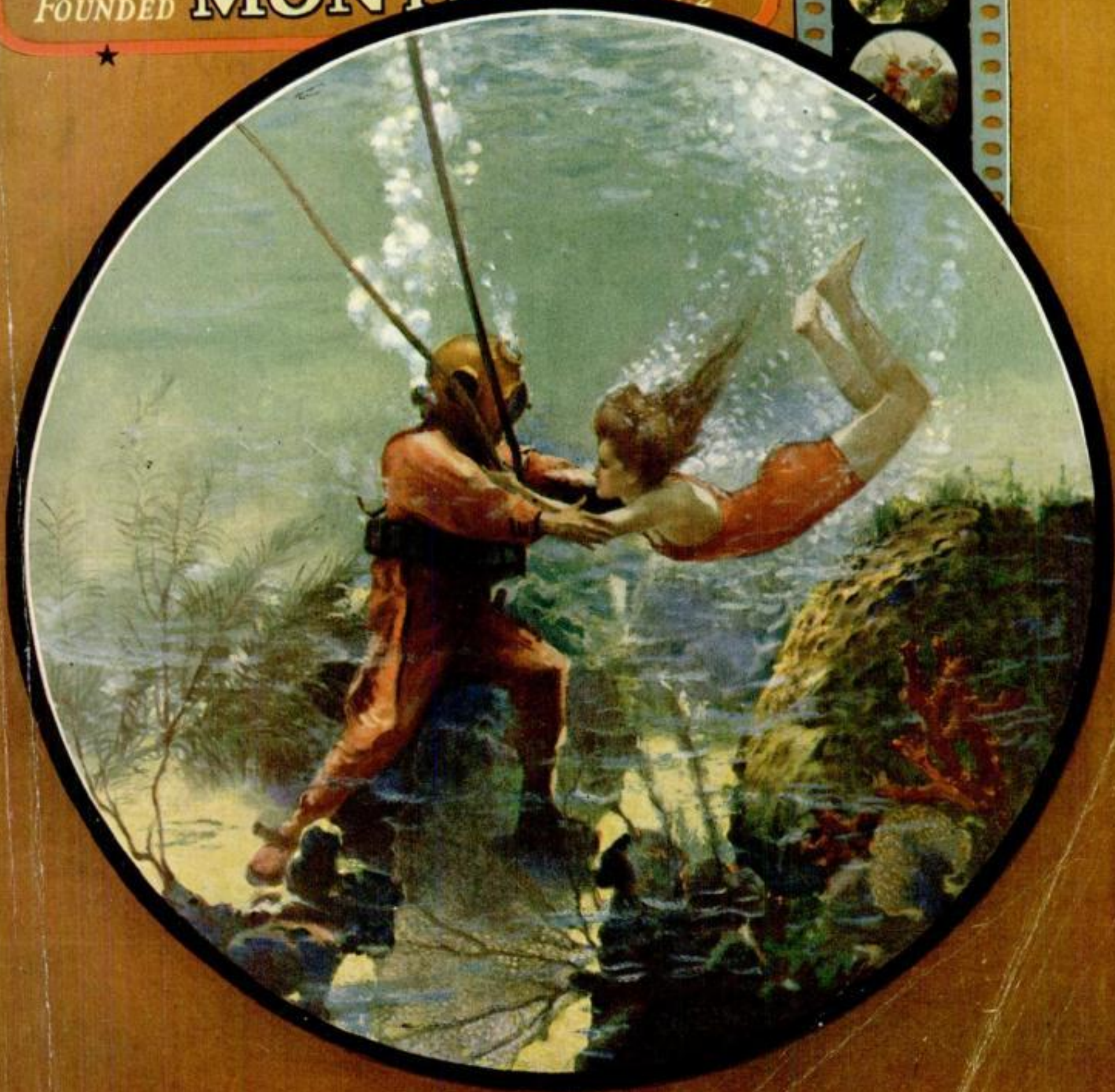


How to Save Your Tires in Winter Driving

Popular Science

FOUNDED MONTHLY 1872



Amazing Beauty of the First Successful Color Movies

Coué's Wonder Secrets of Health and Prosperity

FEBRUARY *Announcing the Year's Most Fascinating Serial* (Page 31) **25 CENTS**



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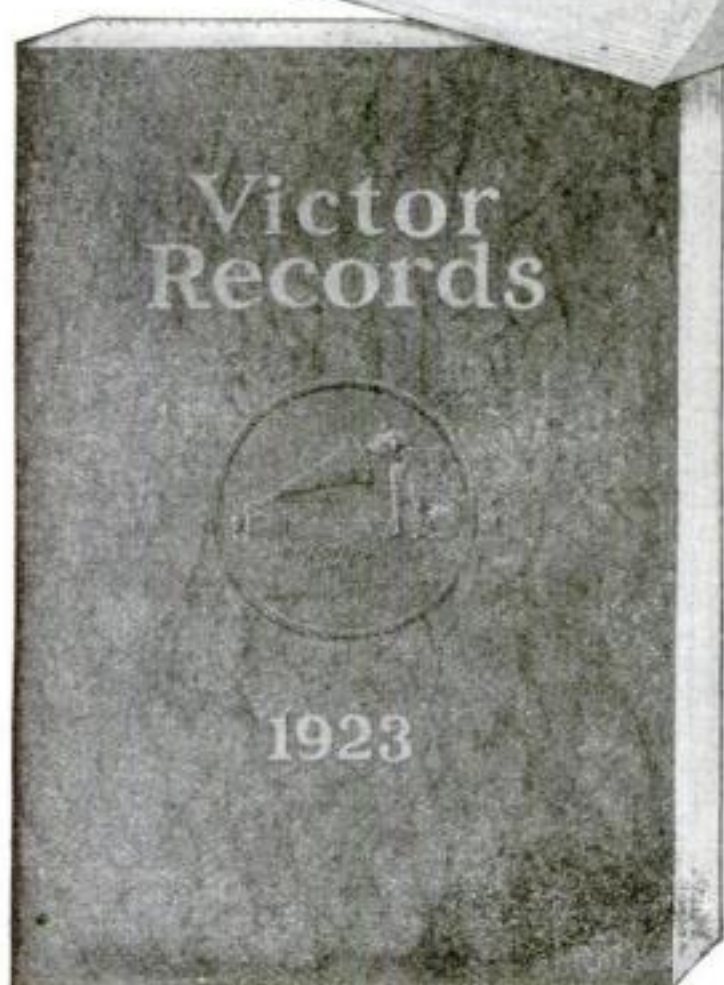
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If all the performances of great music given throughout the world were combined in one mammoth program, they would not even then approximate the music listed for your enjoyment in the Victor Record Catalog. You yourself select the music you wish to hear by the artists you wish to hear.

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POPULAR SCIENCE MONTHLY

FEBRUARY, 1923; Vol. 102, No. 2
25 cents a Copy; \$2.50 a Year



Published in New York City at
225 West Thirty-ninth Street

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Meet the Author of the Year's Most Fascinating Serial

MANY good friends of POPULAR SCIENCE MONTHLY have told us that the story of "How 'Borax' Smith Came Back"—that astonishing romance of science and industry published in our issue of December last—was the best article we ever printed.

There are just two reasons why that story was unique.

The first is because it was a romance of real life.

The other is because it was signed by Dr. E. E. Free—America's foremost writer of popular science. Doctor Free knows how to write. Read his article on "What Is Inside the Earth," in this issue, and see whether you don't feel like voting him a gold medal for making the usually confusing realms of pure science vivid to the layman.

AS ONE of the scant half dozen men of scientific eminence in this country who have the knack of telling the dramatic secrets of science in wholly popular style, E. E. Free was ideally fitted to write the remarkable scientific feature which we are announcing this month.

"The Story of Man and His World," by Doctor Free, has been called "the most fascinating serial ever published by a magazine" simply because it has the same qualities, on a grander scale, that made the "Borax" Smith romance delightful.

It is every word of it stranger than fiction just because it is fact—because it is a story based on the most magnificent of all plots, Nature's great plan of Evolution, more thrilling than any fiction story ever conceived by man. And the other reason it is wonderful reading is that E. E. Free wrote it.

MEMBER of a dozen scientific and techni-



Dr. E. E. Free

Author of "The Story of Man and His World," the fascinating new serial that will begin next month in POPULAR SCIENCE MONTHLY

cal societies, with a degree of Bachelor of Arts in chemistry at Cornell and a doctorate in biology at Johns Hopkins, Doctor Free has been chemical engineer, assistant chemist at the University of Arizona, physicist of the United States Bureau of Soils, scientist for the Department of Agriculture undertaking potash deposit investigations in the Western deserts, and special assistant in the laboratory of plant physiology at Johns Hopkins University.

During the war he served as captain in the Ordnance Department and then as major in the Chemical Warfare Service.

His career has made him an expert in an amazing variety of subjects ranging from geology, chemistry, and engineering, to biology and even scientific detective work!

BUT, most important of all, Doctor Free took to literature. Even while engaged in practical scientific work, he continued to practice that other rare science of writing simple English. He has perfected an unusual ability to introduce the public, in plain, readable but vivid language, to some of that vast store of scientific knowledge that hitherto only scientists like himself have been able to enjoy. Scores of his articles have appeared in popular magazines, in engineering, chemical, and mining journals, and in technical publications of some of the nation's foremost research institutions.

Thus do Doctor Free's versatile scientific knowledge, dynamic personality, and remarkably readable literary style combine to make unique his great panorama of the wonders of science—"The Story of Man and His World," which starts in our next month's issue. Turn to page 31 and read the announcement of this great new serial story, which will continue throughout the year.

POPULAR SCIENCE MONTHLY

Issued monthly. Single copy, 25 cents. Yearly subscription to United States, its possessions, and Canada, \$2.50; foreign countries, \$3.

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H. J. Fisher, President; R. C. Wilson, Vice-President
O. B. Capen, Secretary and Treasurer



The founders of this business are looking for jobs

TWO YEARS AGO the members of the sales department of a manufacturing concern whose product sold faster than it could be made, resigned in a body to build a competing plant. All the money they had or could borrow went into machinery and equipment.

For a while the plant was a beehive of industry. The company introduced to the market a good product at half the price of the older article, and it sold readily.

Today that factory is closed. The equipment will be sold at auction to satisfy debts. And most of the men who founded the business are idle, their savings gone, their assets pledged to creditors.

The magazine "Sales Management," commenting on the tragic incident, says:

"It is the story of every concern that ever started in business with the idea that selling was all there was to business. It is just such calamities as this that prompt us to repeat what we have so often preached—sales managers must study the big, broad phases of business. Make it your business to know the problems of the production man, the credit man, the purchasing agent and last but not least, the financing of the business. . . . There has to be some head to every

business, and that head must be able to see all sides of the problem."

You could hardly compress into one paragraph a better argument for the Alexander Hamilton Institute. It was founded by a group of business leaders who recognized that modern business makes specialists—salesmen, accountants, factory or office managers, credit men, technical men—but does not develop all-round executives. The vital way in which the Institute meets this situation is illustrated by another story.

For fourteen years R. Lee Smith was a sales manager, with an ambition to have a business of his own. "But my work gave me no understanding of business other than that which concerned selling," he wrote to the Institute. "I knew nothing of production, financing or business production."

Instead of setting forth unprepared, Mr. Smith clipped a coupon from an advertisement like this. He received and read "Forging Ahead in Business" and enrolled for the Modern Business Course and Service. With this sound foundation he organized the United Soda Fountain Company which in only three years has become one of the leaders in its industry.

Problems of production, financing, accounting, advertising, credits, did not come to him as new and unfamiliar. "Your Course and Service gave me an understanding of those things," he writes.

This is not an isolated instance. More than 200,000 business men have shared Mr. Smith's experience. They were executives, salesmen, accountants, engineers, lawyers, chemists, bankers, factory and office men. The Institute did not make them better specialists in the one department of business where their experience had been gained. It added to that knowledge a working knowledge of all other departments, with results, in progress and income, which are testified to by thousands of letters voluntarily written.

These men gained their first knowledge of the Institute thru "Forging Ahead in Business," a book which contains all the facts, but so compactly presented that it can be read in an hour. Will you give it an hour in exchange for what it may give you in vision and in counsel? It will be cheerfully sent on this condition. Merely indicate on the coupon the address to which it should be mailed.

Alexander Hamilton Institute
704 Astor Place, New York City

Send me "Forging Ahead in Business" which I may keep without obligation.



Name.....
Print here

Business Address.....

Business Position.....

Canadian Address, C.P.R. Building, Toronto; Australian Address, 42 Hunter Street, Sydney

Here's a Small Taste of the Big March Popular Science Monthly

Readers say that every month POPULAR SCIENCE MONTHLY is growing more interesting. Our extra-large March issue, crammed with fascinating pictures, will surpass even the variety and importance of this number.

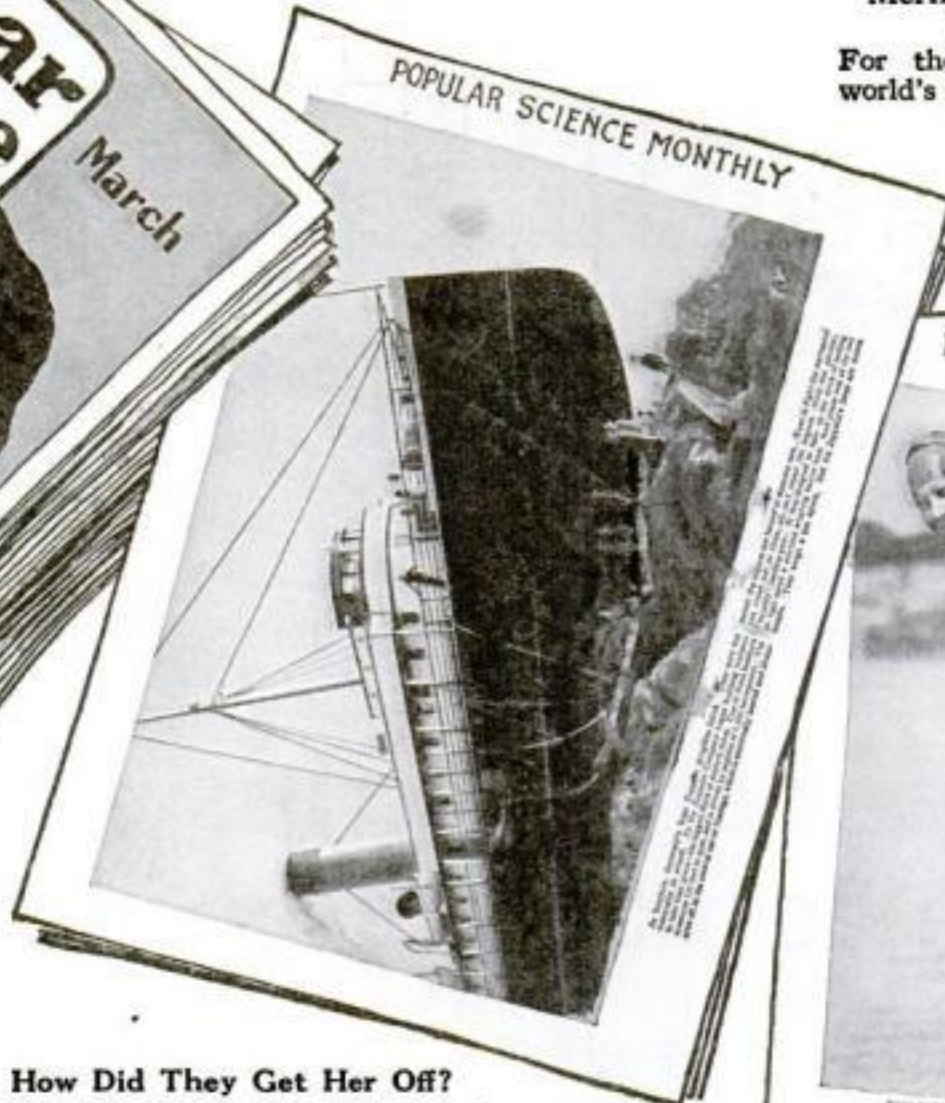
Mermaid Bleibtrey Predicts Women Will Beat Men in Sports

For the first time, a woman has taken a world's sport championship away from men. It was 18-year-old Sybil Bauer who did it. Ethelda Bleibtrey (below), former amateur woman swimming champion, tells why she believes women will out-distance men in sports



How Did They Get Her Off?

The steamship "Empress," stranded with her nose high on the rocks in the North Atlantic, was recently floated by an ingenious engineering trick and the help of the tides. The story of how it was done is only one of a dozen fascinating engineering articles for March



WHY not save time and money by subscribing to POPULAR SCIENCE MONTHLY? An inexpensive subscription will bring you 12 issues of the most expensively edited magazine in the world—the one indispensable publication for every man. In this Age of Science, can you afford to be without the only magazine that covers the entire field of vital scientific progress in easily read, pictorial form? Use the coupon below

P.S.M. 2-23

POPULAR SCIENCE MONTHLY
225 W. 39th St., New York

Please enter my subscription for one year for \$2.50

Name

Address

"The Cave Industry"

How the exhibition of magnificent caves has become a thriving industry in the Shenandoah Valley will be told next month



A Skyscraper Railway

Have you heard about the marvelous new aerial railway, to carry a rapid transit system high over the roofs of skyscrapers, recently proposed to New York's transit officials? Don't miss the description of it next month



Your Deadliest Enemies

Do you know how vaccines are made, and how they combat microbes? At the left you see a colony of your small but mighty bacterial enemies, highly magnified—one of several remarkable photographs from an article in a forthcoming issue on man's fight against germs





An Amazingly Easy Way to Earn \$10,000 a Year

Let Me Show You How Free

TO the average man the \$10,000 a year job is only a dream. Yet today there are a surprising number of men earning five figure salaries who were merely dreaming of them a short while ago. The secret of their success should prove a startling revelation to every ambitious man who has ever aspired to get into the \$10,000 a year class.

There is nothing fundamentally "different" about the man whose salary runs into five figures. He is made of the same stuff as you and I. It is not necessary that he must enjoy the privilege of some influential connection or "pull." For example take J. P. Overstreet, of Denison, Texas. A few short years ago he was a police officer earning less than \$1,000 a year. To-day his earnings are in excess of \$1,000 a month—more than \$12,000 a year. C. W. Campbell, Greensburg, Pa., was formerly a railroad employee on a small salary—last month his earnings were \$1,562.

Why Salesmen Earn Such Big Pay

Just stop a moment and think over the successful men of your acquaintance. How many of them are connected with some form of selling? If you will study any business organization you will see that the big jobs go to the men who sell, for upon their efforts depend the profits a company makes. Without trained men to place a product on the market, the finest goods are worth no more than so much clay. Salesmen are the very nerve centers of a business. Is it any wonder that they earn big pay?

The man who starts working as a bookkeeper or clerk for \$25.00 a week, never increases his value to the firm. Any advance in pay is merely a reward for length of service. At the end of ten years he is no more essential to the life of the organization than he was at the end of ten weeks. He is only a necessary liability—drawing his pay because somebody must be found to work at the unimportant, routine jobs. Once established in the rut, he becomes a cog in the machine—when he is worn out, he can be easily and cheaply replaced.

Why Don't You Get Into the Selling Field?

Mr. Overstreet, Mr. Campbell and the others whose letters you see on this page are all successful salesmen. They realized their ambitions by landing \$10,000 jobs in an amazingly simple way, with the help and guidance of the National Salesmen's Training Association. Sometime—somewhere—back in the past, each one of them read of this remarkable course of Salesmanship training and Employment Service just as you are reading of it to-day. Each one of them was dissatisfied with his earning capacity—as perhaps you are—and each one cast his lot with the N. S. T. A. To-day they are important factors in the business world—enjoying all the comforts and

luxuries money can buy. And yet they are not exceptions, for there are thousands of N. S. T. A. trained salesmen who are making big money, as we will be only too glad to show you if you will mail the coupon.

We Train You and Help You Land a Job

The National Salesmen's Training Association is an organization of top-notch salesmen and sales managers formed for the express purpose of training men in the science of successful selling. You do not need to know the first thing about selling—for the N. S. T. A. trains you from the ground up—gives you a complete insight into selling methods—in your spare time without making it necessary to give up your present position until you are ready to begin actual selling.

Read These Amazing Stories of Quick Success

Earned \$524 in Two Weeks

I have never earned more than \$60 a month. Last week I cleared \$306 and this week \$218. You have done wonders for me.—Geo. W. Kearns, Oklahoma City, Okla.

I Now Earn as High as \$100 a day

I took your course two years ago. Was earning \$16 a week clerking. Am now selling many of the largest firms in the U. S. I have earned more than \$100 in a day. You secured me my position. Our Sales Manager is a graduate of yours.—J. L. DeBonis, Chicago, Ill.

Earns \$1,562 in Thirty Days

My earnings for the past thirty days are \$1,562, and I won Second Prize in March although I only worked two weeks during that month.—C. W. Campbell, Greensburg, Pa.

Earned \$1,800 in Six Weeks

As soon as I received a letter from you and your literature, I knew that I was on the right track and very soon after I applied for a position as a Salesman to one of the firms whom you informed me were in need of a Salesman and to whom you had recommended me. As soon as they received my application, which was by mail, they wired me to come for an appointment which I did, with the result being that I sold my service to them in about thirty minutes, took a territory in Illinois and Wisconsin and made a success of it from the very first week.

From that time on I have been what might be termed as a "high pressure" Salesman, selling lines where nine out of ten Order Takers would fail. I have sold goods in a highly successful manner in nine or ten States, both North and South. My earnings for March were over \$1,000 and over \$1,800 for the last six weeks, while last week my earnings were \$356.00. I travel eleven months out of the year, working five days each week.

The N. S. T. A. dug me out of a rut where I was earning less than \$1,000 a year and showed me how to make a success.—J. P. Overstreet, Denison, Texas.

In addition to this remarkably efficient course of training, the N. S. T. A. maintains a Free Employment Service to help its Members to jobs in the lines for which they are best suited. This in itself is of incalculable value for it allows the prospective salesman to make a complete survey of the selling field and to select the work which most appeals to him.

Salesmen Are Needed—Now!

Get out of that rut! Work for yourself! Salesmanship is the biggest paid of all professions. Just because you have never sold anything is no sign that you can't. We have made Star Salesmen of men from all walks of life, with no previous selling experience. These men have jumped from small pay jobs to big selling positions and handsome incomes. The same training on which they founded their success is open to you. You can follow in their footsteps. Why don't you get in a class with men who make real money? Never before have the opportunities been greater. At least you cannot afford not to investigate the great field of selling and see what it offers you. It will only cost you a 2-cent stamp and the facts and proof you will receive will surprise you.

Free Book on Salesmanship



Just mail the coupon or write for our free Illustrated Book, "Modern Salesmanship," which we will be glad to send without any obligation on your part. Let us prove to you that regardless of what you are doing now, you can quickly become a Star Salesman. Let us show you how you too can step into the ranks of these big money makers of business. See how easily you can learn this fascinating, big pay profession at home in your spare time. Learn what we have done for others and what we stand ready to do for you. Don't put it off until to-morrow—write us to-day. Every hour lost keeps you that much farther from success. Mail the coupon at once

National Salesmen's Training Association
Dept. 15-B, Chicago, Ill., U. S. A.

National Salesmen's Training Association
Dept. 15-B, Chicago, Ill., U. S. A.

Please send me, without any obligation on my part, your free Book, "Modern Salesmanship," and full information about the N. S. T. A. system of Salesmanship training and Employment Service. Also a list showing lines of business with openings for salesmen.

Name.....
Street.....
City.....
Age..... Occupation.....

GRADE	THE UNITED STATES OF AMERICA	NUMBER
THIRD GRADE	DEPARTMENT OF COMMERCE	5505
	BUREAU OF NAVIGATION	
	LICENSE	
	RADIO OPERATOR, COMMERCIAL FIRST CLASS	

This is to certify that ALFRED HENRY BARTLEY has been examined and passed, pursuant to the Radiotelegraphic Convention, on:

- adjustment, operation, and care of apparatus;
- transmitting and sound reading, at a speed of not less than twenty words a minute, Continental Morse;
- use and care of storage battery or other auxiliary;
- knowledge of international regulations and Acts of Congress to regulate radio communication.

and is hereby licensed, as required by law, a Radio Operator, Commercial First Class for two years. The candidate's practical knowledge of adjustment was tested on a set of apparatus. His knowledge of other systems is shown below:

Code speed	20 WORDS PER MINUTE	Percentage	82.3%
<i>R. Y. Brown</i>			
Radio Inspector			
(1902)			
Place	Baltimore, Md.	Date	June 24th 1922

Notary Public: *Herbert Hoover*, Secretary of Commerce
D. R. CARSON, Commissioner of Navigation

Get This First Class Radio License You Can Earn Big Money With It

THE best paid positions in Radio go to the men who hold the Government's Commercial License. The radio men on every ship, in every land commercial station, in every broadcasting station, must have one of these licenses. Every radio inspector must pass the first-class license examinations. Engineers, mechanics, installation and maintenance experts must all of them own a Government First-Class Commercial License. It is every radio man's ambition to get a license, not only because it is the highest mark of honor he can get but because it also opens to him all the wonderful opportunities in this great profession.

Emmett Welch of Peculiar, Mo., Radio Salesman, earns \$300 per month and expenses paid. Merle M. Wetzell, while taking our course, was advanced from a lineman to Inspector in the Engineering Department of a Public Service Co. with a big increase in salary. George Staffa, as operator aboard ship, averaged \$125 a month with all expenses paid. Read in the panel of the fine salaries paid in all the wonderful positions open to you as soon as you get the Government First-Class License.

Win Your First Class Government License This New, Easy Way

The National Radio Institute, America's first and largest Radio School, has devised a remarkable new method that makes it easy for you to win your license. No previous experience in electricity or radio is necessary. Lessons, so fascinating they read like an interesting romance, take you step by step through the whole wonderful science of radio. Spare time study at home prepares you in an amazingly short time to pass the government examinations, so you can get one of the fine jobs waiting in this great field.

Prominent radio experts give you personal instruction and advice. They grade your papers, answer your questions, give you every help you want so you can qualify quickly. The diploma we give you upon completion of the course, counts for 5 to 10 credits on all government license examinations. The most important

National Radio Institute, Dept. 12B, Washington, D. C.

Send me your free book, "How to Learn Radio at Home," with full particulars about the opportunities in radio, and how you will quickly train me in my spare time at home to win a Government First-Class Commercial License. Also tell me how your free Employment Service will help me to a position.

Name.....Age.....

Street.....

City.....State.....

requirements for a commercial license is a knowledge of the Radio Code. One of the most extraordinary features of the Institute's comprehensive course is the four patented instruments, invented and owned by the National Radio Institute, give you the practical training in radio operation, installation, maintenance and repair which you must have to become an expert.

Four Radio Instruments Free

Among these instruments is the wonderful Natrometer, said by experts to be the most perfect device ever invented to teach the Radio Code. With this amazing machine you quickly learn how to send and receive code with all the speed, the accuracy and precision of a trained expert operator. No extra equipment is necessary. Simply connect a dry cell, adjust the head-phone, wind the motor, and for twenty minutes you can listen to a reproduction of the code-work of two of the most expert trans-Atlantic operators.

Interesting Book on Radio Free

Get into this fascinating profession now. The field is wide open; thousands of positions are open. Find out at once your opportunities in radio. Send for the interesting free book, "How To Learn Radio at Home," which gives complete details of the plan by which the National Radio Institute qualifies you quickly in your spare time at home for a Government Commercial License. If you are sincerely ambitious to win success and wealth in radio, send the coupon, or a postcard, now.

Pick Out the Job You Want We Will Help You Get It

This is a brief list of the positions in the Radio field today, and the salaries paid:

Radio Mechanic	\$1,500 to \$2,000 a year.
Radio Inspector	\$1,800 to \$3,000 a year.
Radio Auditor	\$1,200 to \$1,800 a year.
Radio Salesman	\$2,000 to \$5,000 a year.
Radio Engineer	\$3,500 a year and up.
Radio Executive	up to \$10,000 a year.
Radio Aid	\$6 to \$10 a day.
Radio Draftsman	\$7 to \$10 a day.
First Class Ship Operator	\$105 a month, all expenses paid.
Commercial Land Station Operator	\$150 a month and up.
Broadcasting Station Operator	\$125 to \$250 a month.

SUCCEEDED IN GETTING LICENSE

I have taken the Radio Course from you by correspondence and have finished it. Now I have succeeded in getting a commercial first grade license. I can operate most any spark station and can also operate an arc and tube transmitter. **CHARLES ROSSI**, 31 Runyon Ave., Yonkers, N. Y.

GETS \$165 A MONTH

I am the only operator on board the "Lake Tulare" and receive a salary of \$125 a month, with an additional \$3 a day food-allowance while in port, totaling a cash pay of approximately \$165 a month. **LEO A. GOLDBLATT**, Baltimore, Md.

IN CHARGE OF RADIO DEPARTMENT AND ADVERTISING MANAGER

I presume that you are somewhat interested in the amount of success the graduates of your school attain. The degree of success which your graduates arrive at is a criterion by which the school is judged by others. As you know I completed your prescribed course in Radio Telegraphy and Radio Telephony on July 21, 1920. At the present time I have complete charge of the Radio Department of True & Blanchard, Inc., of this place. This firm deals both retail and wholesale in Radio Equipment and Supplies. I also have charge of the advertising of The Vermont Radio Company of this city. **REGINALD T. ALBEE**, Advertising Manager, Vermont Radio Company, Newport, Vermont.

EASY TO GET GOOD JOB

Only a short letter to let you know that I am still on board and waiting for the ship to sail. Tell your students for me that a man with a license has no trouble obtaining a good position. Believe me, a job like this is worth a good deal of studying. **L. M. WARING, JR.**, S. S. Lake Farnley, Norfolk, Va.

\$7.00 A DAY AS OPERATOR

Just sailed this morning for Norfolk, where we are to get a load of coal. I haven't much to do on board, and when in port not that much. I get \$7.00 a day when in port, and can sleep on the ship. Not bad at all. **REVERE B. GURLEY**, On board S.S. "Lake Figart."

NATIONAL RADIO INSTITUTE

Dept. 12B, 1345 Pennsylvania Ave., N.W., Washington, D. C.



He Never Amounted to Much in School— But Look at Him Today!

"**S**ORT of a nobody in school, he was. Not stupid—just a drifter. He seemed born to be merely a cog in the world's machinery. No one would have given him a second thought if suddenly he hadn't begun to rise in his job, and go up and up—Look, he's coming in."

Burroughs, the speaker, raised a warning finger. The busy room had hushed. Twenty men's unfinished arguments, questions, challenges, seemed to hang suspended in the air. The entire convention, obviously sincere and terribly in earnest, silenced half-spoken words and faced about the huge mahogany table, tense with eagerness.

There had entered the turbulent room the man they awaited—the man who was to lead these distressed, perplexed men by sheer force of his superior mental skill—who was to sway them to one common idea, one concerted action, one single, sound, successful purpose, and transform their impotence into Power.

He was not an awe-inspiring figure to look at. But his personality dominated. With perhaps one-fourth the schooling of those around him, he faced them with quiet assurance and perfect poise.

He looked silently but understandingly into their upturned faces, and, as if by the miracle of his smile, excitement changed to calm.

"Gentlemen," he said (and you could have heard a pin drop, "I am happy to tell you that our problem is solved."

Then, without notes or memoranda, without the slightest trace of effort, he swung into what he had to say. He stated the case. He dissected the complex and analyzed it into the simple. He discarded the futile. He weighed the essentials in every aspect of related value. Doubts were dissipated, objections swept away by the clearness of his logic, the power of his reasoning. Swiftly, irresistibly, he led up to the one and only solution, presented it with mighty force and stepped down amid a roar of applause the like of which I had never heard.

When I met this marvelous man again—which you may be sure I did the first chance I got—he rather took my breath by saying in his quiet, modest way in the midst of my congratulations:

"You are not fair to yourself to praise me for something you can do as easily as I. We both have normal native ability. And with that any one can do what you mistakenly praise me for."

"You don't believe it," he continued. "Suppose I illustrate. Isn't it true that you know people who succeed better in your field of work than you? Have these people more than your original ability? Not at all. Well, then, isn't it plain that they succeed better simply because they have trained their minds to work better?"

He pressed a little book into my hand, said "Think it over" and "Good-bye," and was gone.

I stood there doing perhaps the first real thinking of my life. Here I was striving for success,

yet doing nothing to strengthen and develop my mind, the only part of me with which I could hope to win. I was no more efficient mentally than a month ago—or a year ago.

I had not even taken a hint from the office bookkeeper, who, by acquiring the easily-learned habit of adding two columns of figures at once, had speeded his work and raised his salary. I was standing still. I was that biggest of all fools—the man who fools himself.

The Secret of Mental Power

That evening I studied the little book "The Secret of Mental Power," the most interesting and mind-spurring book I have ever read. It showed how the great tragedy of modern life is that 99 out of every 100 have an equal chance to win—but that less than one in 10,000 ever learns to use the brains that Nature gave him.

It showed how there can be no investment of time and money that pays such large and certain dividends as development of the ability to think straight. It went on to tell of a marvelous course in mental clearness and accuracy, prepared so that you or I can train ourselves, simply and easily, in odds and ends of spare time that now go to waste—a course so practical in character that it can be applied day by day directly in our work and to our immediate advantage and profit.

New Pleasure in Living

By methods as fascinating as a delightful game you learn to understand yourself by self-analysis.

The Secret of Mental Power

Get This FREE BOOK

—if you want to know:

- How to analyze yourself
- How to awaken "pep"
- How to establish habits of thought
- How to end fears and worries
- How to adapt yourself
- How to use your temper
- How to concentrate without effort
- How to win an argument
- How to overcome self-consciousness
- How to make a mental store house
- How to size-up, judge and foresee
- How to master important problems
- How to enjoy your career.



You pick up the keys that some day will open a wealth of personal mind-powers you never knew existed. Your interest in life wakes up. You are encouraged. You feel a sudden all-conquering desire to develop your mind to the highest possible degree. You are happier than you have ever been before.

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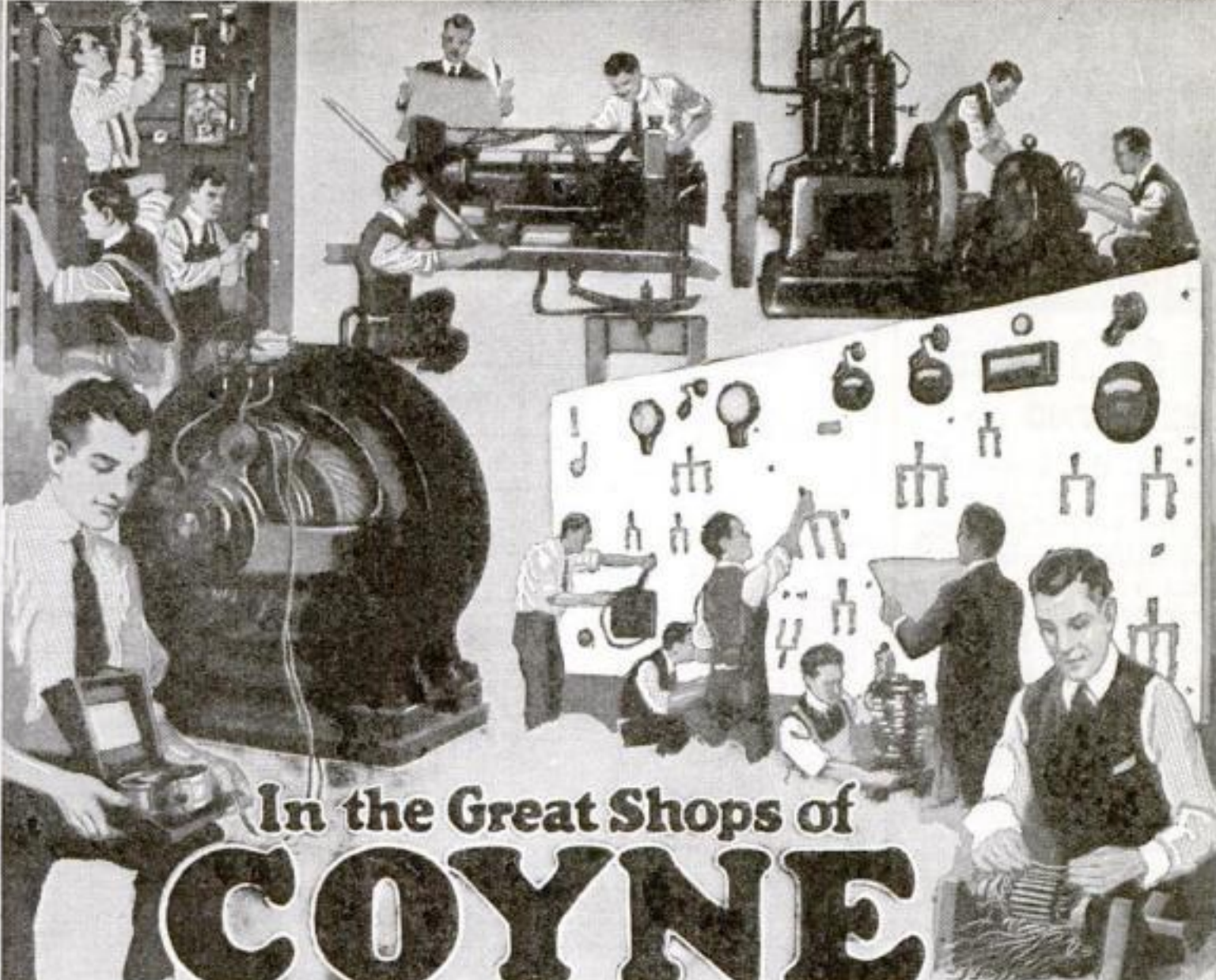
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"Good-Bye - I'm Very Glad to Have Met You"

But he *isn't* glad. He is smiling to hide his confusion. He would have given anything to avoid the embarrassment, the discomfort he has just experienced. Every day people who are not used to good society make the mistake that he is making. Do you know what it is? Can you point it out?

HE couldn't know, of course, that he was going to meet his sister's best chum—and that she was going to introduce him to one of the most charming young women he had ever seen. If he had known, he could have been prepared. Instead of being ill at ease and embarrassed, he could have been entirely calm and well poised. Instead of blustering and blundering for all the world as though he had never spoken to a woman before, he could have had a delightful little chat.

And now, while they are turning to go, he realizes what a clumsy boor he must seem to be—how ill-bred they must think him. How annoying these little unexpected problems can be! How aggravating to be taken off one's guard! It must be a wonderful feeling to know exactly what to do and say at all times, under all circumstances.

"Good-bye, I'm very glad to have met you," he says in an effort to cover up his other blunders. Another blunder, though he doesn't realize it! Any well-bred person knows that he made a mistake, that he committed a social error. It is just such little blunders as these that rob us of our poise and dignity—and at moments when we need this poise and dignity more than ever.

What Was His Blunder?

Do you know what his blunder was? Do you know why it was incorrect for him to say "Good-bye, I'm very glad to have met you?" What would you say if you had been introduced to a woman and were leaving her? What would you do if you encountered her again the next day? Would you offer your hand in greeting—or would you wait until she gave the first sign of recognition?

Many of us who do not know exactly what the correct thing is to do, say, write and wear on all occasions, are being constantly confronted by puzzling little problems of conduct. In the dining-room we wonder whether celery may be taken up in the fingers or not, how asparagus should be eaten, the correct way to use the finger bowl. In the ballroom we are ill at ease when the music ceases and we do not know what to say to our partner. At the theatre we are uncertain whether or not a woman may be left alone during intermission, which seat

the man should take and which the woman, who precedes when walking down the aisle.

Wherever we go some little problem of conduct is sure to arise. If we know exactly what to do or say, the problem vanishes. But if we do not know what to do or say, we hesitate—and blunder. Often it is very embarrassing—especially when we realize just a moment too late that we have done or said something that is not correct.

Just a Few of the Chapter Titles

A Plea for Dancing
Automobile Etiquette
When the Bachelor is Host
Tipping at the Hotel
Woman in the Business World
A Trip to the South
At Tea-Room and Roof Garden
The Origin of Manners
Announcing the Engagement
Responsibility for the Wedding
How to Acknowledge an Invitation
When to Introduce—and How
Asking a new Acquaintance to Call
The "Bread-and-Butter Letter"
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Why the Shy are Awkward
Planning Surprises

—and countless other fascinating chapters that you will read and re-read many times and find permanently helpful to you.

Are You Sure of Yourself?

If you received an invitation to a very important formal function today, what would you do? Would you sit right down and acknowledge it with thanks or regrets, or would you wait a few days? Would you know exactly what is correct to wear to a formal evening function? Would you be absolutely sure of avoiding embarrassment in the dining-room, the drawing-room, when arriving and when leaving?

Everyone knows that good manners make "good mixers." If you always know the right thing to do and say, no social door will be barred to you, you will never feel out of place no matter where or with whom you happen to be. Many people make up in grace and ease of manner what they lack in wealth or position.

People instinctively respect the well-bred, well-mannered man and woman. They are eager to invite them to their homes, to entertain them, to introduce them to their friends.

Do you feel "alone" at a social gathering, or do you know how to make yourself an integral part of the function—how to create conversation and keep it flowing smoothly, how to make and acknowledge introductions, how to ask for a dance if you are a man, how to accept it if you are a woman?

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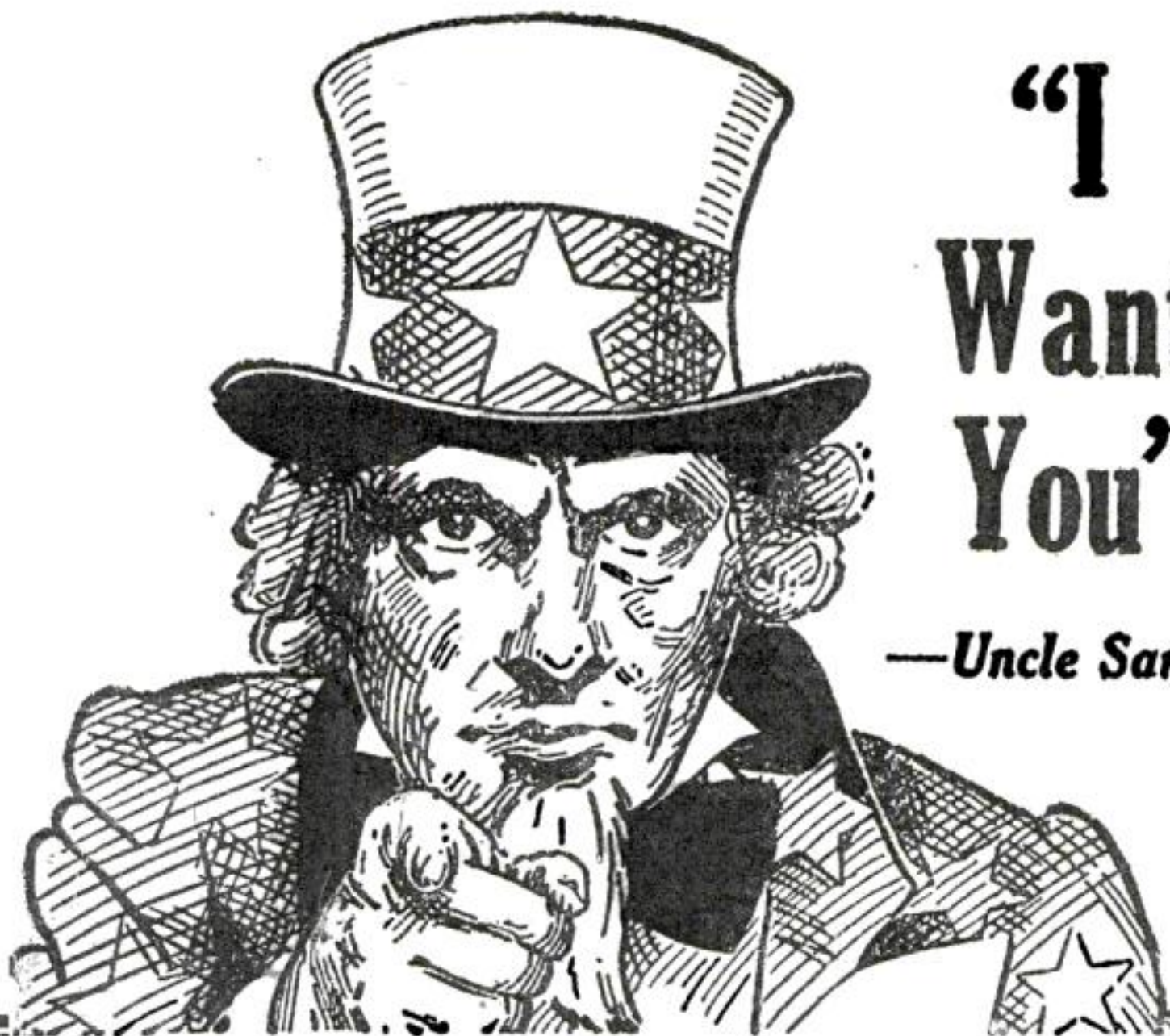
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**For Eight Years I Was Tied to a Job In
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By George Glick

For eight years I worked in a retail store, and as far as salaries go for that kind of work, I was doing pretty well. I got my \$40.00 every Saturday, and I suppose I should have been happy, but somehow or other, that \$40.00 a week wouldn't buy me everything I wanted. Expenses piled up something awful. Baby had to have new shoes mighty often, Florence had to have her music lessons; my savings account didn't grow, I didn't carry enough insurance; I felt I wasn't getting anywhere.

Then one day, Mort Lyons, who had worked with me for years, dropped into the store and after the usual greetings, he told me what he was doing. I was surprised when he told me that he was averaging better than \$80.00 a week. Now Mort is a pretty good salesman, but I knew I could outsell him. I had always been a hard-worker, and was rated a better salesman. It set me thinking, if Mort can earn \$80.00 a week, why can't I?

Mort told me of his connection with J. B. Simpson and of the wonderful clothes they make to retail at \$29.50. From what he said of the firm, I knew they must be first class, and Mort wouldn't be identified with anyone that wasn't. And when he showed me his samples, my eyes nearly popped out. There were the same fabrics for \$29.50 that we were selling at \$50.00 and even \$65.00. "But, Mort," I said, "how can they do it?" "That's a wonderful story in itself," said Mort, "which I'll tell you later."

I thought it over for the next few days, but I just didn't have the nerve to make the plunge. Separating myself from \$40.00 a week sure and certain, rain or shine, seemed to me a very risky proposition. I talked it over with my wife and as usual, she had a good suggestion. She said, "George, take your vacation now. It's January. Business is dull in

your store, and they will be glad to have you go now."

Well, the next week I started out and by the following Saturday I had earned \$36.00. The next week I made \$52.00 and had enough prospects lined up to bring me \$50.00 more. I went back to the store and quit my job. They laughed at me when I told them what I was going to do. "You'll be back in a month," they said, "begging for your job;" but believe me, they couldn't give me enough money to ever get me back into that old hole in the wall.

I have been at it now for a year, last month I made \$520.00, the month before, I made \$538.00; my earnings for the first year in this business will be about \$4,850.00, and next year I will increase that by at least one or two thousand dollars.

I am sitting pretty now. I've got a connection with the finest outfit you could possibly imagine, honest and honorable people offering values that positively cannot be duplicated by anyone else. How they can do it is the wonder of everybody.

One day I made a trip through their tailor shops and believe me, it opened my eyes. I found them cutting trimmings without any waste by a process exclusively their own. I saw methods used by them that I had never heard of before, and I thought I knew something about making clothes as well as selling them. I found them buying wools and paying less than half of what we used to pay in our little store. I found them applying the principle of many sales and small profits and the highest efficiency in every department throughout their entire establishment.

Believe me, it was a lucky day for me when I heard of J. B. SIMPSON.

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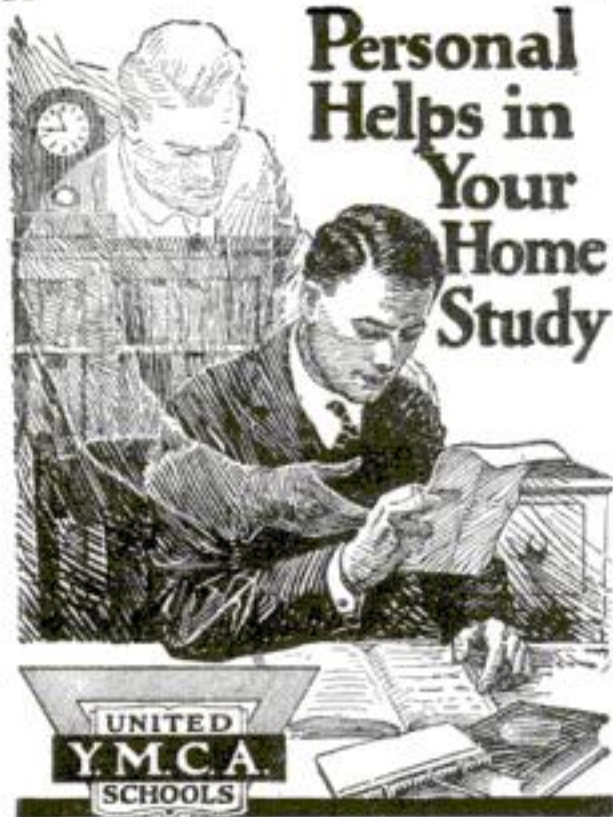
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MAKE easy money selling printing. No collecting or delivering. Adverpress, Station C-5, Milwaukee.

SALESMEN that have been or are calling on electric or radio trade, see Mr. Rice, 6311 N. Clark St., Chicago.

AGENTS—Something new, think of it! 33c. profit on every 35c. sale. What is it? Sample free. Empire Company, 7201 Atlantic, Ventnor, Atlantic City, New Jersey.

WHY work for others? Make and sell your own goods. We show you how. Enormous profits. Write quick for free book explaining everything. National Scientific Laboratories, 213 North Monroe, Richmond, Virginia.

SCHEMER Magazine, Alliance, Ohio, prints big profit schemes: one agent making \$25,000 from three; another \$10,000 from one. Try your luck. Year, only \$1.00; 3 months, 25c.

MANUFACTURER offers exceptional opportunity to those capable of organizing salesforce of women to handle a product universally in demand by women. Write American Rubber Products Co., 612 Fifth Avenue, Pittsburgh, Pennsylvania.

AGENTS—A demonstration sells our marvel can opener and doubles your money. Cinch your success with our proposition. Staples Mfg. Co., Box 288, Mt. Vernon, Indiana.

AGENTS—625% Profit—Salesmen. New Article. Big demand. Business and professional men must have it. \$25.00 to \$50.00 upwards daily. Ellen, Ohio, books 14 orders out of 16 calls in 3 hours, profit, \$95.00. Men capable of handling one or more states desired but not absolutely necessary. Write at once stating territory desired. Sample Free. Business Builders, Dept. 110, Athens, N. Y.

NIFTY Auto Specialty. Discounts handsome. Catalog Auto Washer Company, Dept. N., Topeka, Kansas.

AGENTS: If you are making less than \$300 a month, our proposition on Sentinel Burglar Alarms for windows and doors will interest you. Many agents earn \$20 daily. Brand new inventions. No wires or batteries. Instantly attached to any door or window. No competition. Provides cheap burglar insurance. Big money makers. Write to-day for extremely liberal terms to agents. Sentinel Alarm Co., 1452 Marquette Bldg., Chicago, Illinois.

EARN \$10.00 to \$35.00 weekly mailing circulars at home. Outfit and instructions 25c. Jamorris, 2305 Gratz, Philadelphia, Pennsylvania.

AGENTS—Mason sold 18 Comet Sprayers and Auto-washers one Saturday. Profits \$2.50 each. Particulars free. Established 30 years. Rusler Co., Johnstown, Ohio, Dept. 23-A.

AGENTS with Fords, \$20.00 a day selling brass water circulating pumps, \$4.00, sells for \$10.00. Shock absorbers and snubber, \$3.50, sells for \$8.50. Nickel bumper F or R, \$5.50, sells for \$12.00. Explosive whistle brass, \$2.00, sells for \$4.50. All guaranteed first class. Enclose money order for any item, will ship at once so you can start selling. Universal Mfg. Co., 1110 S. Michigan, Chicago.

27,000 records guaranteed with one Everplay Phonograph Needle; new, different, cannot injure records. \$10.00 daily easy. Free sample to workers. Everplay, Desk 215, McClurg Bldg., Chicago.

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OUR genuine gold window sign letters are an excellent money-making proposition for handy men. Slana Sign System, East Bethune Avenue, Detroit, Michigan.

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WRITE photoplays; \$50 each. Experience unnecessary, details free to beginners. Producers' League, 194, St. Louis.

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BE a detective. Excellent opportunity, good pay, travel; Write C. T. Ludwig, 424 Westover Bldg., Kansas City, Missouri.

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BE a railway traffic inspector! \$110 to \$250 monthly, expenses paid, after 3 months' spare-time study. Splendid opportunities. Position guaranteed or money refunded. Write for Free Booklet Cm-13. Standard Business Training Institute, Buffalo, New York.

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MEN wanted for detective work. Experience unnecessary. Write for details explaining guaranteed position. J. Ganor, former Govt. Detective, DU, St. Louis, Missouri.

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GOVERNMENT railway mail clerks start \$133 month; expenses paid. Specimen examination questions free. Columbus Institute, N-2, Columbus, Ohio.

ALL men, women, boys, girls, 17 to 60, willing to accept government positions, \$117-\$190, traveling or stationary, write Mr. Osmont, 295 St. Louis, immediately.

FIREMEN, brakemen, baggagemen, sleeping car, train porters (colored). \$140-\$200. Experience unnecessary. 838 Railway Bureau, East St. Louis, Illinois.

U. S. Government wants help. Railway mail clerks, clerks at Washington. Men-women, over 17. \$100-\$195 month. List positions free. Franklin Institute, Dept. M42, Rochester, New York.

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This book thoroughly covers the entire field of amateur radio work, including the theory and design of amateur wireless transmitters and receivers, the construction of transformers, high voltage condensers, spark gaps, aerials, masts, and receiving sets for long and short wave receptions. 330 pp. Fully illustrated. Price \$2.25

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USED correspondence courses sold, rented, and exchanged. List free. (Courses bought.) Lee Mountain, Piznah, Alabama.

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WE start in business, furnishing everything. Men and women, \$30.00 to \$100.00 weekly, operating our "New System Specialty Candy Factories" anywhere. Opportunity lifetime. Booklet free. H. Ragdale Company, East Orange, New Jersey.

SELL by mail. Big profit opportunities free. Harvey Teeple, Decatur, Indiana.

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OPPORTUNITY to start lucrative business, little capital; avoid risk of credits; or carrying merchandise. Write Dept. 152, Paul Kaye, 149 Broadway, New York.

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\$400 CLEAR each day, anybody can do that with Our Equipment, canvassing and experience unnecessary, send 30c in silver with Reference for particulars. Triple Block Motor Works, Garfield, Washington.

STAMPS AND COINS

CALIFORNIA gold \$1/4 size, 27c; \$1/2 size, 53c. White cent and catalogue, 10c. Norman Shultz, Colorado Springs, Colorado.

HAVING no office I can offer these bargains. 1000 American hinges and 100 different stamps, 25c. 100 British Colonies, 35c. Get my free price list and try my "approval service." Elwood D. Weber, 812 South Avenue, Plainfield, New Jersey.

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STAMPS—50 varieties, Africa, Brazil, Peru, Cuba, Mexico, etc., and Album 10c. 50 different U. S. 25c. 1,000 hinges, 10c. 1,000 mixed, 40c. List free. I buy stamps. C. Stegman, 5949 Cole Brilliante, St. Louis, Missouri.

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TRY Gopher approvals. Priced net. Specify countries desired. Reference. Gopher Stamp Company, 3515 Third Avenue South, Minneapolis.

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WONDER packet stamps, 10c. Approvals. Buckey, 712-A Bowen, Dayton, Ohio.

COINS, medals, paper money, antique firearms, swords, stamps, relics. Catalogue free. Collector's Exchange, 1536 Wilmington, Philadelphia.

103 DIFFERENT stamps, including German airplane, Flume triangle, China, only 10 cents. J. B. Mustek, 4440 Natural Bridge, St. Louis, Missouri.

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WHY not spend Spring, Summer and Fall gathering butterflies, insects? I buy hundreds of kinds for collections. Some worth \$1 to \$7 each. Simple outdoor work with my instructions, pictures, price list. Get posted now. Send 10c (Not Stamps) for my Illustrated Prospectus. Mr. Sinclair, Dealer in Insects, Dept. 7, Ocean Park, Calif.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

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Your Satisfaction Guaranteed So sure am I that you can learn Electricity—so sure am I that after studying with me, you, too, can get into the "big money" class in electrical work, that I will guarantee under bond to return every single penny paid to me in tuition if, when you have finished my course, you are not satisfied it was the best investment you ever made.

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I want to send you an Electrical Book and Proof Lessons both FREE. These cost you nothing and you'll enjoy them. Make the start today for a bright future in Electricity. Send in Coupon—NOW.

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Dear Sir:—Send at once the "Vital Facts" containing Sample Lessons, your Big Book, and full particulars of your Free Outfit and Home Study Course—all fully prepaid, without obligation on my part.

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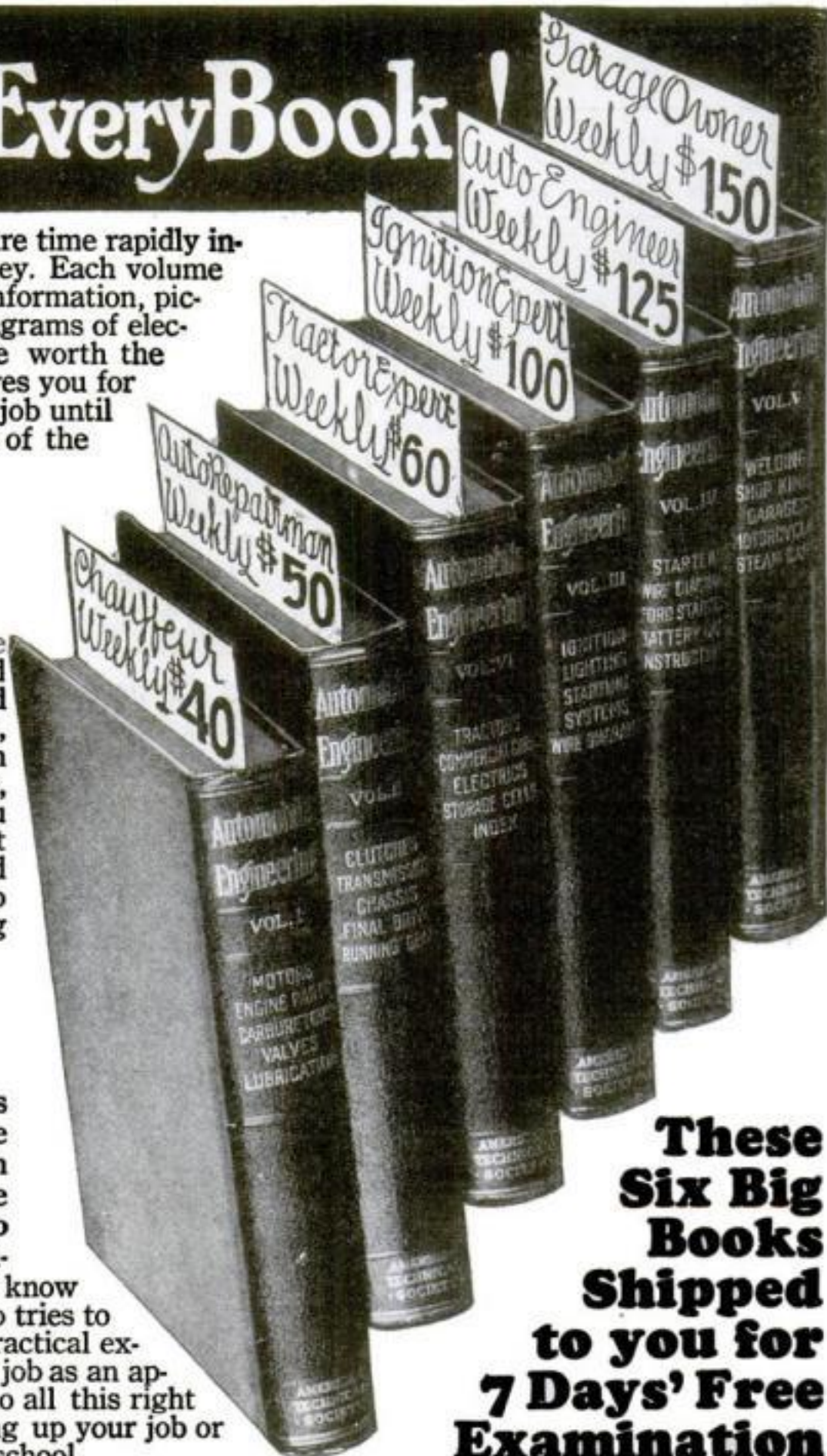
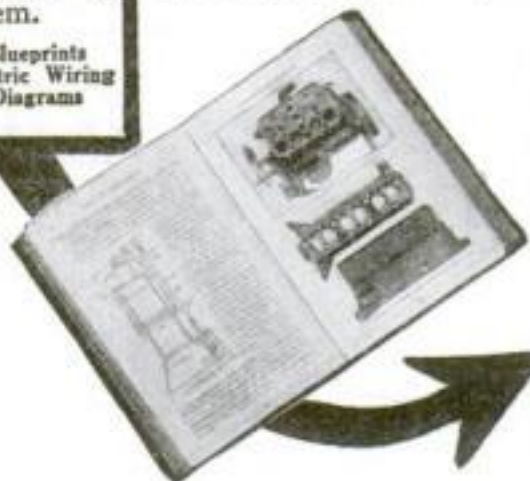
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Men of the Hour in Science

Intimate Glimpses of Foremost
Leaders in Research
and Discovery



Dr. Alexis Carrel

AS SURGEON of the Rockefeller Institute, New York, Doctor Carrel has entered hitherto unexplored realms of scientific research to learn secrets of why we live, why we become sick, and why we die. In experiments with living body cells—in the course of which he has kept an isolated piece of chicken heart alive and growing for six years!—he has discovered startling new facts about white corpuscles. These corpuscles, he has just announced, not only destroy microbes, but stimulate healthful new growth in body tissues attacked by them.

Ernest De K. Leffingwell



IN THE central picture is Ernest Leffingwell, of California—athlete, explorer, scientist, horticulturist, and owner of the highest honor medal within the gift of the British Royal Geographical Society. He is not only responsible for starting Vilhjalmur Stefansson on his historic Arctic explorations—with results described in the last *POPULAR SCIENCE MONTHLY*—but through his own explorations has given us the first accurate map of the whole north shore of Alaska. In addition, Leffingwell's adventurous explorations have cleared up many scientific problems relating to the Far North.



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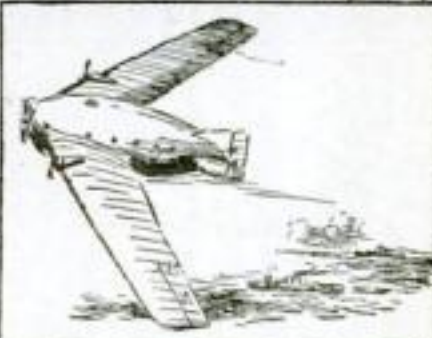
Dr. Vernon Kellogg

IN HIS capacity as permanent secretary of the National Research Council, Doctor Kellogg (at left), like *POPULAR SCIENCE MONTHLY*, is endeavoring to unite the forces of science, industry, and education for the solution of public welfare problems, by interesting industry in the results of scientific research, and by developing a new generation of scientifically trained young men.

For this undertaking he is fitted by years of successful effort as a professor at Leland Stanford and as chief investigator for Hoover in war relief work.



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Lieut. Charles Nungesser

NOT content with fame and fortune, this retired "ace" of the French Army, who brought down 105 enemy planes during the war, is devoting his practical knowledge to further conquest of the air.

He recently announced the invention of an entirely new type of seaplane—egg-shaped body with queer wings—in which he hopes to fly from Paris to New York in 24 hours, and later to establish regular transatlantic passenger transportation. He plans also to build "jitney" seaplanes to sell for \$1000 each.

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and knows there is no limit to dimension."
said Chuang Tzu.

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From \$5-a-Week Beginner to Scientific Chief of the World's Greatest Telephone System

How J. J. Carty, Directing Marvelous Research Work by Army of 3000 Scientists, Has Developed Our Phone Service "Half a Century Ahead of Its Time"

By Harry A. Mount

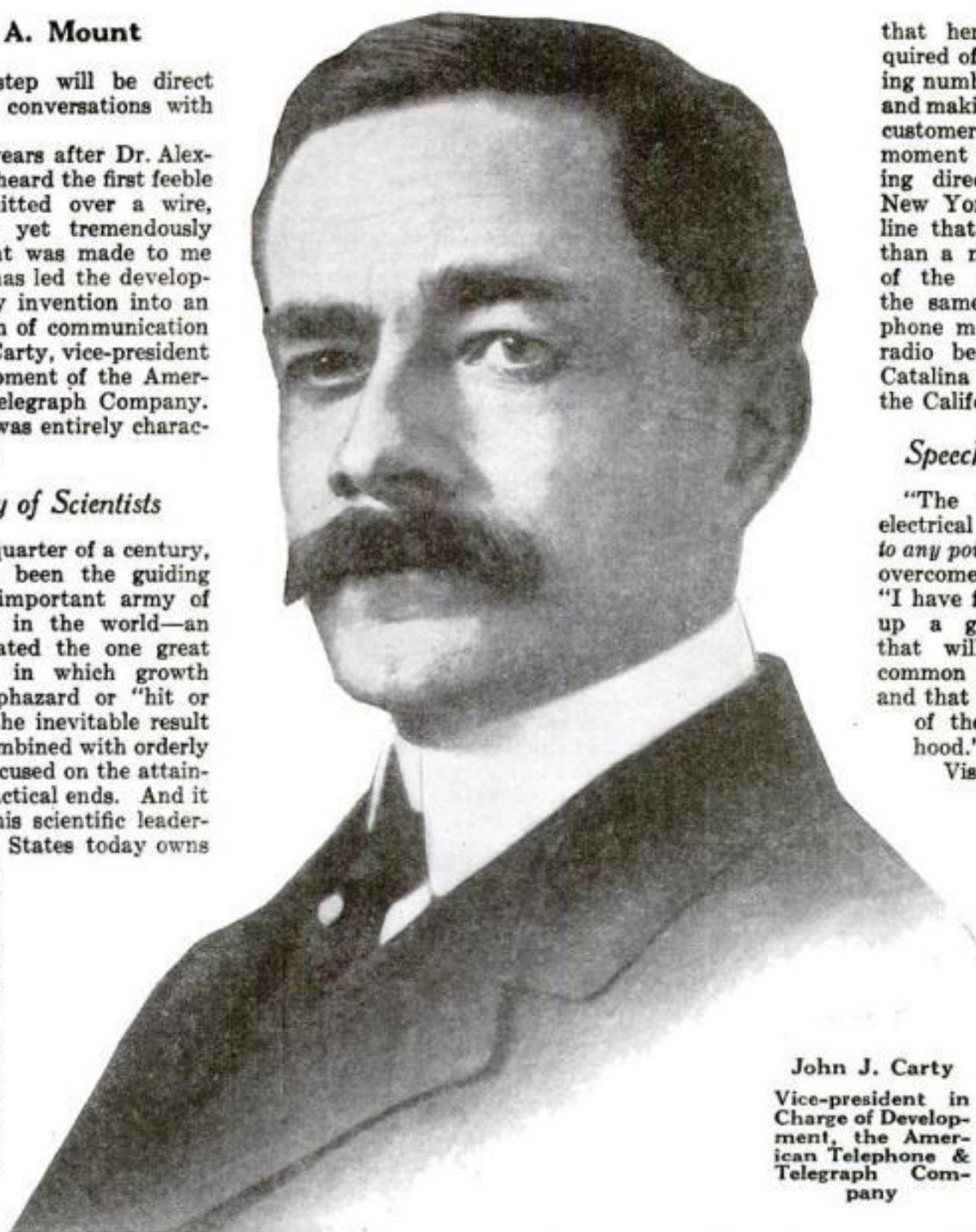
THE next step will be direct telephone conversations with Europe."

Just 47 years after Dr. Alexander Graham Bell heard the first feeble sound ever transmitted over a wire, this matter-of-fact, yet tremendously significant statement was made to me by the genius who has led the development of Bell's baby invention into an indispensable system of communication—by Gen. John J. Carty, vice-president in charge of development of the American Telephone & Telegraph Company. And the statement was entirely characteristic of the man.

A Great Army of Scientists

For more than a quarter of a century, General Carty has been the guiding chief of the most important army of industrial scientists in the world—an army that has created the one great American industry in which growth never has been haphazard or "hit or miss," but always the inevitable result of keen foresight, combined with orderly scientific research focused on the attainment of definite, practical ends. And it is largely through his scientific leadership that the United States today owns and operates one third of all the world's telephones.

My conversation with Carty took place in an office on the twenty-sixth floor of a great building in New York which is the very nerve center of the vast network of telephone lines stretching from sea to sea—and beyond. While we talked, gangs were at work in a dozen large cities of the United States making the first installations of a marvelous new system of automatic switching that performs, without the touch of a human hand, all of the intricate functions



John J. Carty
Vice-president in
Charge of Develop-
ment, the Amer-
ican Telephone &
Telegraph Com-
pany

What Organized Research Has Given You in Service

FORTY-FIVE years ago, John J. Carty, then a retiring youth of 16, was working for five dollars a week on a telephone system that consisted of a few iron wires strung about the city of Boston. Today he leads the technical development of the one great industry that has progressed, not because of occasional inventive brilliancy or haphazard driving power, but because of the application of orderly, scientific methods.

Telephone communication in America is what it is today—at least half a century in advance of other nations—because General Carty and his staff of 3000 engineers learned how to foresee the problems of their industry, and to have the solution of these problems completed when the time came to meet them.

This is the true way of exact science—the way of untiring research, and of final fulfillment in valuable service.

that heretofore have been required of "central," even to ringing numbers on distant exchanges and making proper charges against customers' bills. At that same moment two operators were making direct connections between New York and Havana, over a line that at one point lies more than a mile beneath the waters of the Gulf Stream. And at the same moment, routine telephone messages were passing by radio between an exchange on Catalina Island and another on the California mainland.

Speech Around the World

"The physical obstacles to electrical transmission of speech to any point in the world have been overcome," I heard Carty saying. "I have faith that we shall build up a great telephone system that will bring into being a common language for all nations, and that will join all the peoples of the earth in one brotherhood."

Visionary? Wait until you know Carty, the practical doer of "impossible" deeds. Here is a man who, as a youth of slight build and somewhat retiring disposition, went to work at five dollars a week on a telephone system consisting of a few iron wires strung about the city of Boston, and a few crude instruments, used both as transmitters and receivers, which sometimes would work if one shouted into them.

At the end of three years, in 1880, young Carty had quietly introduced the first great advance toward the modern telephone—the full metallic circuit—and was fairly launched on his remarkable career as



The first telephone exchange, 1885—from a contemporary drawing. Here an operator, seated at a "central desk," shouted incoming calls to boy assistants who dashed about the room pushing brass pegs into holes and so making connections

an industrial general before whom a host of "scientifically impossible" obstacles in the way of the modern telephone has retreated.

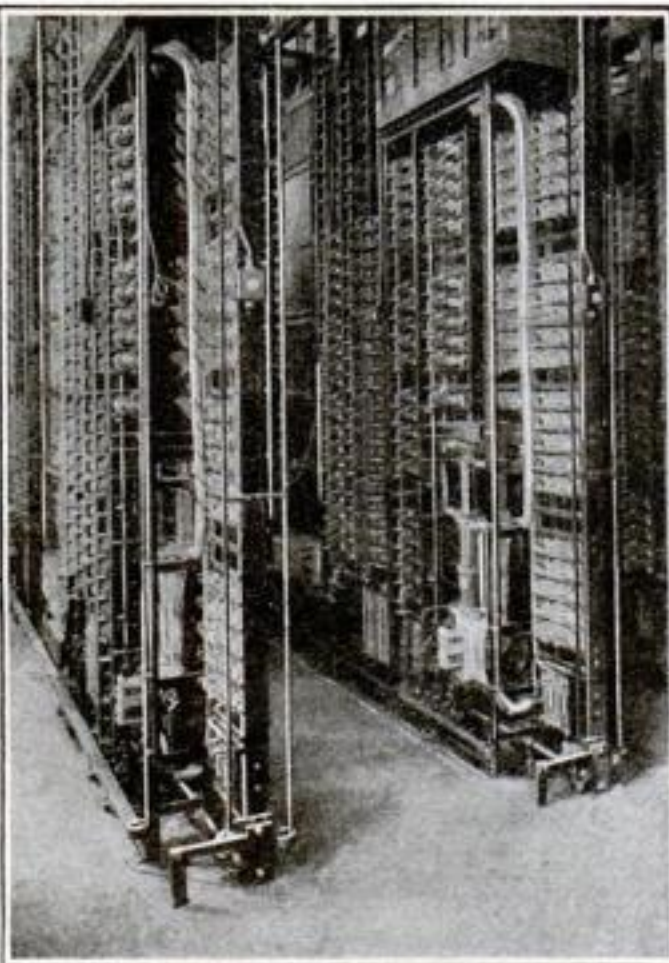
Not once, but again and again, Carty and his co-workers in telephone development faced apparently insurmountable situations that threatened not only to halt further advance of the telephone, but even to destroy the existing system. Indeed, an entirely new industry had to be built from the ground up; for at the time Carty became one of the guiding geniuses of the telephone, the wisest men knew less about delicate electrical voice currents than does the average high school boy of today. Even Alexander Graham Bell, who planted the seed of the great enterprise that bears his name, could do little more than supply the great inventive idea—an idea so crudely worked out at first that while a person could telephone across the street, the instrument and system were entirely ineffective at greater distances.

Every Step Carefully Planned

Each advance since that day has been deliberately planned, worked out in a laboratory, and finally executed with the cooperation of many minds. There has been no single creator of the telephone. But guiding and directing the whole course of telephone evolution has been the genius of Carty, first as manager of equipment and traffic for the original Telephone Despatch Company; later as chief engineer for the New York Telephone Company; finally as chief engineer and now vice-president of the American Telephone & Telegraph Company.

Today he is head of a force of more than 3000 scientists, engineers, and assistants whose job it is to improve and extend telephone service. Under his guidance science applied to industry has had its most grandiose test; and as a result of this tireless effort to solve vast problems by scientific research years before they actually became acute, it is safe to say that the system now in service in the United States is fully half a century ahead of its time as measured by "normal" progress in Europe.

When Carty entered the business, iron wire was used and each individual wire carried one tele-



A marvel of modern telephony—the automatic switchboard that enables telephone users to make their own connections accurately without the aid of a human "central." This intricate, silent sentinel—born out of the hubbub and clatter of oldtime exchanges—is the outcome of the Bell laboratories, direction of scientific research work

phone connection, the ground being used to complete the circuit.

"All manner of squeaks, squawks, and howls came over the wire," said Carty, recalling the difficulties of these early circuits; "but if you shouted at the top of your voice, sometimes you could manage to be heard at the other end. When two wires were strung side by side, the effect of induction was such that if a person talked at either end of one of the lines, you could hear his voice at the distant end of either line."

But the faith of Carty and his colleagues in the telephone reached beyond the limitations of their instruments. One of Carty's first big jobs was to string up a "long distance" line between Boston and Lawrence, Mass., a distance of about 26 miles. This



This is an actual photograph of one of the first crude multiple switchboards, showing "central" operators at work. These instruments, the forerunners of our modern switchboards, connected only a few hundred telephone subscribers

was to supply a newspaper office with telephone service—a feat that required the services of a telegraph operator stationed at the end of the line to take the messages in code whenever the telephone should refuse to work!

In the construction of the line, two wires were put up to provide two circuits and it was in the study of these two circuits that Carty conceived an idea that was destined to become tremendously important in telephone communication. He determined to use one of the wires in place of the ground, as a return circuit. He gave a workman instructions as to how to hitch up the instruments at Lawrence and he himself made the connections at Boston. Then he spoke over the line to the girl operator at Lawrence—and a miracle occurred. The line was perfectly quiet!

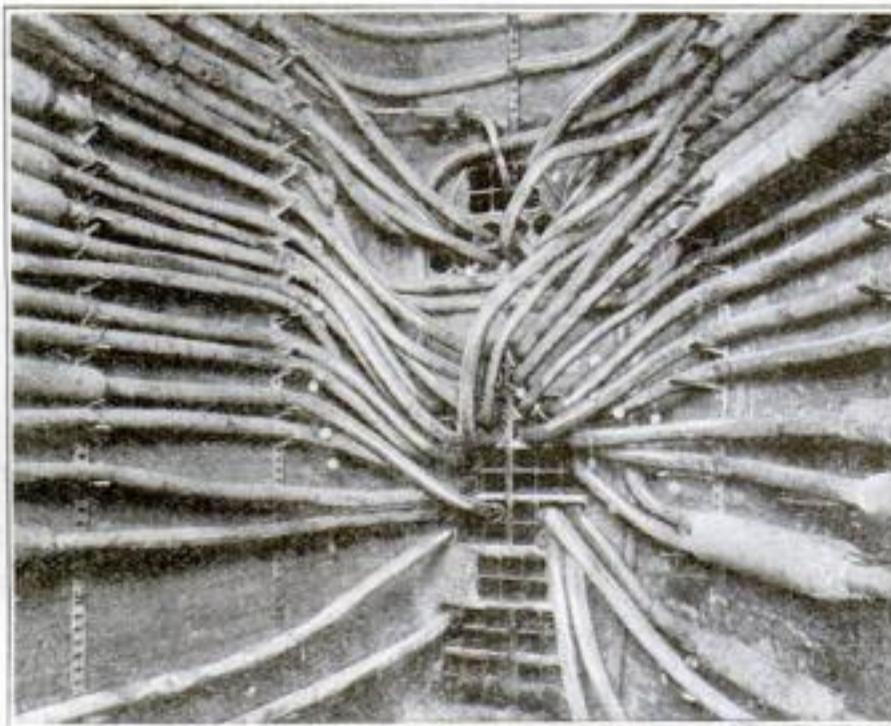
The Full Metallic Circuit

"What did you do?" cried the astonished operator, when she heard Carty's voice.

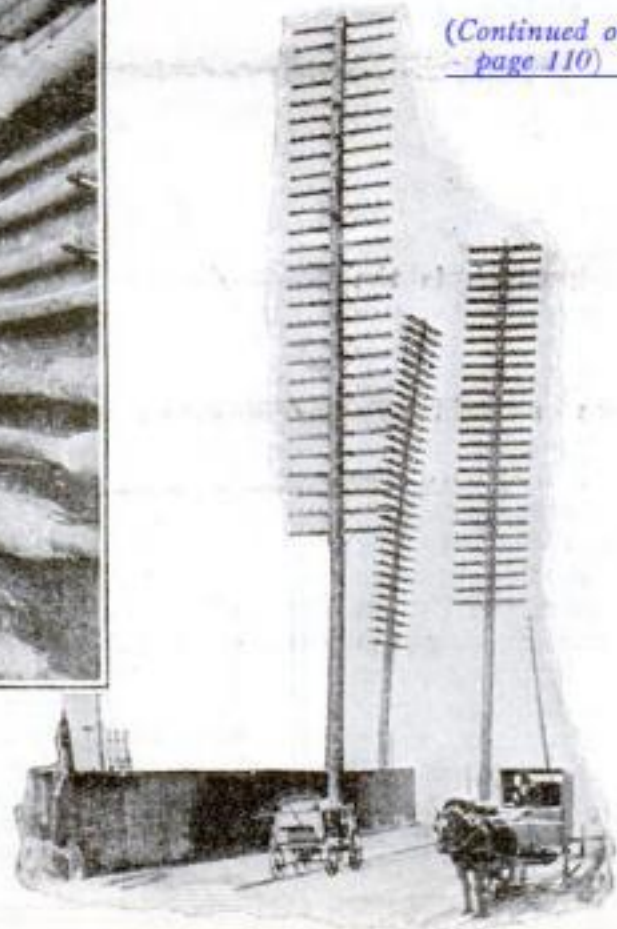
"Why," replied Carty, "I am using a full metallic circuit."

"Gee," said the girl enviously, "I wish we had one of those things down here!"

Then came a new problem. It was found that when two full metallic circuit lines were built side by side, induction or "cross talk" occurred much more readily than before. Hundreds of devices



AT THE right are the tallest telephone poles ever erected, as they appeared in New York twenty years ago. Such monstrosities, built to meet increasing business, resulted in public demand that the lines be put under ground—as shown above. The cables in this conduit are the busiest in the world. While the poles carried about 280 wires, the cables shown contain 22,624 wires



(Continued on page 110)

Airtight Tank to Prevent Huge Oil Loss

New Fireproof Floating Roof Designed to Reduce \$100,000,000 Annual Fuel Waste, Caused by Flames and Evaporation

WOULD you believe that you could envelop a tank full of fuel oil with a roaring fire without inviting certain disaster?

By doing that very thing during tests of a newly devised floating safety roof, experimenters of the Underwriters' Laboratory recently demonstrated not only that oil tanks can be safeguarded from fire, but that the millions of dollars' worth of oil and its by-products lost each year through fire, lightning, and evaporation, can be saved.

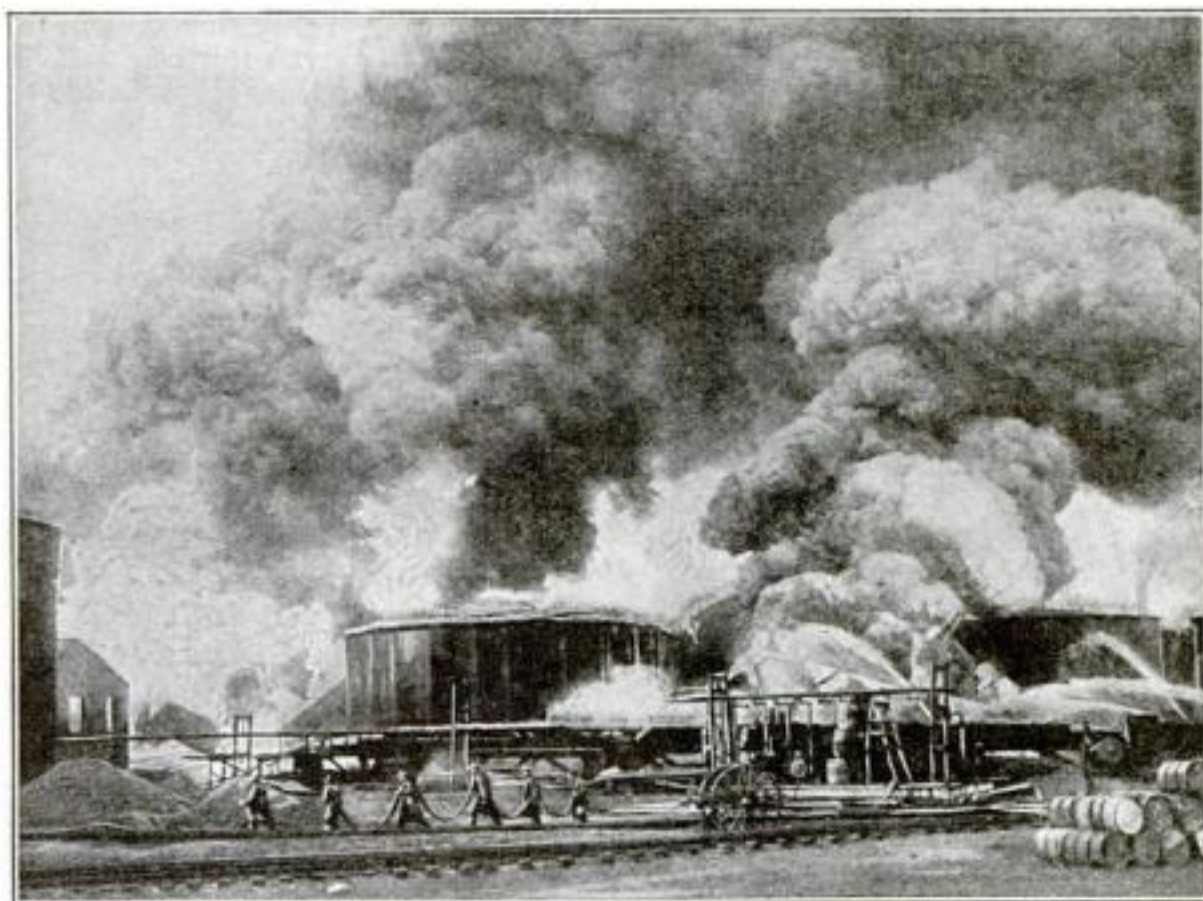
Piling inflammable material on the top and around the sides of a model tank equipped with the safety roof, the experimenters poured oil on the tinder, set fire to it, then watched to see what would happen. And while the flames leaped high, this is what did happen:

Oil Boils without Igniting

The oil in the tank actually boiled from the terrific heat yet it neither exploded nor ignited. After the fire had died down, the tank and its contents remained unscathed!

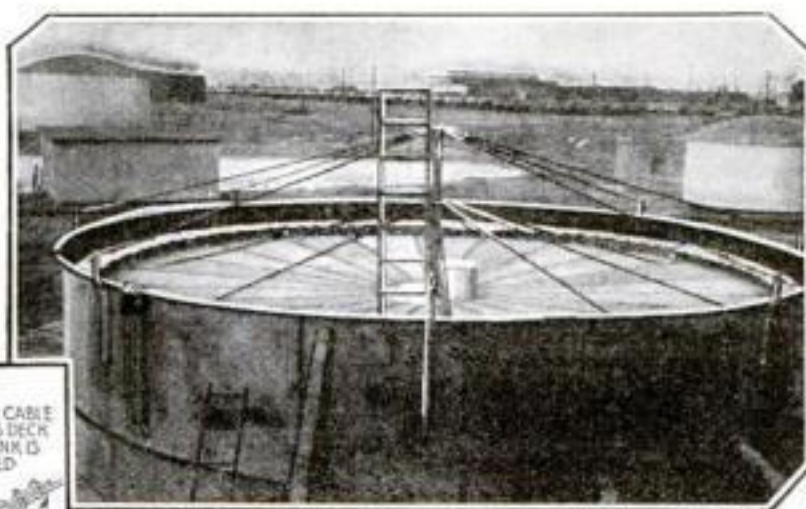
The safety roof that protected the oil throughout this amazing test is said to be the crowning achievement of inventors who have been endeavoring to relieve the increasing shortage in our available gasoline and oil supply—a shortage due in a large measure to evaporation and destruction by fire.

The total loss of oil by evaporation each year is estimated at 600,000,000 gallons, valued at about \$150,000,000. On the way from the wells to the refineries 300,000,000 gallons of gasoline, evaporating from the crude petroleum, is wasted annually in the air, repre-



A lightning bolt, striking one of the great tanks at the Tidewater oil plant, Bayonne, N. J., started this destructive conflagration—typical of the preventable

fires that destroy \$7,500,000 worth of oil and \$6,500,000 in property in the United States each year. To reduce this loss the airtight tank has been designed



An oil tank made fireproof and evaporation proof by a newly invented roof that floats on the surface of the oil, thus excluding oxygen necessary for combustion

senting a preventable loss of \$75,000,000. In addition, \$7,500,000 worth of oil is destroyed annually by fire and lightning in devastating conflagrations that destroy \$6,500,000 worth of other property and often result in loss of life.

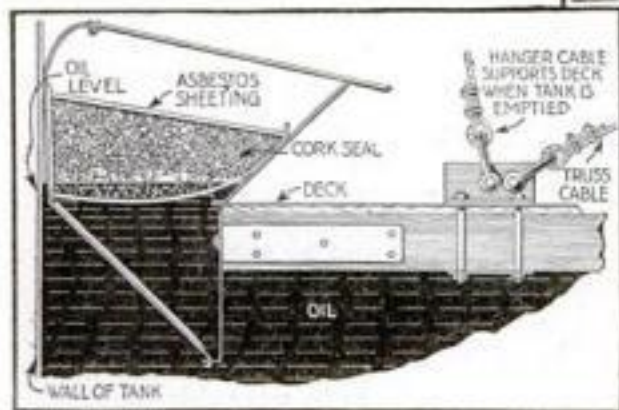
The critical need of lessening such

tremendous losses, led to the invention of the new safety roof, which can be adjusted to fit any oil tank. It is said to be fireproof, lightning proof, and evaporation proof, and consists of a floating cover, the circumference of which is built slightly smaller than that of the tank it is designed to fit. This floating roof rests on the surface of the oil so that no air may intervene between that surface and the roof.

How Roof Is Sealed

Surrounding the floating roof and lying against the wall of the tank is a gravel or cork "seal," which fills in the space between the rim of the roof and the tank, and automatically adjusts itself to irregularities.

This seal is provided with a deck that turns rainfall onto the main roof, which is equipped with pipes to drain off the water. Investigation has shown that oil fires resulting from lightning are due to the fact that lightning sets off highly combustible gases that accumulate in tanks.



Cross-section diagram of safety oil tank showing construction of floating roof that precludes fire and evaporation. Note cork seal filling space between rim of the circular roof and the tank wall



Preparing the fire test. The tank, filled with fuel oil, is covered with inflammable material that is saturated with oil



Enveloped in flames. Heated to the boiling point by the test fire, fuel oil in the tank neither exploded nor did it ignite



Through the fire unscathed. Here is the tank as it appeared at the conclusion of the test, its contents untouched by the flames

Coué Brings His Magic Health Secrets to America!

COUÉ is here!

He was scheduled to arrive in America the week this magazine appears on the newsstands.

Emile Coué is one of the most spectacular figures in the world today. He is popularly known as the greatest individual healer in history. At his modest home in Nancy, France, this modern miracle worker is reported to have cured 20,000 persons of a host of serious ailments. Crutches, observers tell us, are thrown away, cripples walk, paralyzed limbs are taught to move again.

A small town druggist of dynamic personality, who became a student of autosuggestion, Coué in the past 10 years has played host and healer to an army of sick and crippled peasants that came in pilgrimage to his doors.

Wins Fame by His Cures

More recently, called to England to demonstrate his powers, he gained fame by curing Lord Curzon of "a dangerous and stubborn malady," while scores of others in England claimed benefit from the novel treatment which now he is to demonstrate in this country.

But the most spectacular part of Coué's work is that he claims for himself no healing power at all—he merely teaches you to cure yourself, by the mysterious force of autosuggestion.

Everybody today knows this wonderworker's famous phrase, "Day by day, in every way, I am getting better and better." So common a catchword has it become that it is a model for endless newspaper jokes. But before you are led astray by ridicule, think of the effect of repeating an opposite phrase. Suppose you should say to yourself, in gloomy seriousness night and morning for months, "Day by day, in every way, I am getting sicker and sicker!" Common experience will prove to you that you would soon become depressed and ailing in fact, as a result of such a daily dose of unhealthy suggestion.

In that fact alone you have evidence of the powers of autosuggestion. Coué's results are accomplished by the operation of well known laws. Briefly, you have two distinct minds—the objective, or conscious, which receives all the impression from the outside world through your five senses; and the subjective, or unconscious, which controls the automatic functions of your body such as breathing, digestion, the beating of the heart, muscular and nervous reactions, and the processes of eliminating waste from the system.

The Power of the Unconscious

With the former we think, weigh alternatives, and deal with the material things in the world about us. The unconscious is the source of our dreams, the storehouse of our memory and of all the impressions that the world has made upon us—indeed, of a myriad impressions that we were not conscious of even as we received them. And this unconscious mind, guiding the functions of our organs, keeps us well, happy, and successful if we but give it the chance. But if we fill it with ideas of gloom and failure, it guides our actions not toward

By Edwin F. Bowers, M.D.

Author of "Teeth and Health," etc.

health and success, but toward disaster.

The secret of autosuggestion, then, as preached by Coué, is to implant in this unconscious mind the conviction of health and success. But how can this be done? We know by the new science of psychology that

over as you repeat the phrase is merely a bit of ritual that permits you to be sure of plenty of repetition of the phrase without actually counting with your conscious mind, and so keeping the latter alert and defiant of the unconscious. The words are repeated aloud because thus the maximum of impression is made upon the unconscious by the muscular movements of mouth and throat and the nerve sensation of the ear, with the minimum of attention from the conscious mind.

Many familiar experiences in life may be taken as instances to explain what Coué is driving at. In a game of baseball, one member of the team regularly plays magnificently. This is because the idea of success is deeply implanted in his unconscious mind, and the unconscious attends to all the instantaneous reactions of eye and nerve and muscle that make him hit and run and catch to perfection.

But another—a new player—is never quite sure of himself. He constantly though vaguely imagines himself failing to catch or hit the ball. Then, by a curious law of psychology, which Coué announces, the harder he wills to make a brilliant catch, the less chance he has of doing so. His imagination—dimly picturing failure—and his will—determined to succeed—are in desperate conflict, and in every such conflict the will loses.

Fear Grips Imagination

In many people, apparently, the imagination, feeding by its very nature upon the spectacular, is more ready to seize the dramatic or terrifying possibilities of failure than the calmer facts of success. Pictures of spectacular crashes, of disaster gathering like the storm, of falling from great heights, of making a glorious botch of what we are doing, seem to appeal to the imagination more than

(Continued on page 113)



Photo courtesy American Library Service

Emile Coué, known as the world's greatest faith healer, surrounded by just a few of one day's health-seeking pilgrims to his home. Reliable observers who have watched his work in Nancy, France, tell of amazing cures wrought by the methods of autosuggestion he teaches—of cripples who, after a short Coué treatment, throw away their crutches and run gaily up and down the garden

the unconscious is accessible only when the conscious mind drowns—when you are daydreaming, or half asleep. When your conscious mind is alert, it doesn't allow the unconscious a chance to realize its dreams.

Now Coué has invented a new method of feeding thoughts of health and success to the unconscious.

The rhythm of saying aloud over and over again, as you fall asleep, "Every day in every way I am getting better and better," serves to lull the conscious mind to inattention and by its repetition fixes the idea of universal improvement in health and ability in the unconscious. The string tied with twenty knots that you tell

Try This Experiment on Yourself

TO DEMONSTRATE the power of your unconscious thought to transform itself into action, tie an eight-inch string to the end of a pencil, and to the other end of the string attach a heavy metal button.



Holding the pencil firmly in both hands, as shown, but without pressing your arms tensely to your side, suspend the button over the intersection of two diameters crossing at right angles in a circle, 10 inches across, previously drawn on a piece of paper.

Now let your eyes follow the line of one of the diameters. Soon the button will begin to swing along that line. Next, concentrate for a time on the other diameter; later, let your eyes follow the line of the circle. Each time, the movement of the button will change to follow the line you are thinking of, despite the efforts of your will to hold the pencil motionless.

What Is Inside the Earth?

Amazing Scientific Discoveries Give New Explanation of Volcanic Flames—Earth's Center May Be Solid Mass of Precious Metals

By E. E. Free

ONE of the greatest of all scientific mysteries lies literally under your feet. It is the mystery of what is inside the earth.

Suppose you devised some kind of powerful digging machine, capable of withstanding terrific heat and pressure, and suppose you climbed inside it and started downward through the rock and kept on going, mile after mile, until you penetrated all the 3956 miles down to the center of the earth. What would you discover on the trip? What materials would you have to bore through?

No doubt you would expect to find a blazing central inferno of gases and molten metal. No doubt you have been led to believe this because it seems to explain the flames and seething lava that issue from volcanoes. The explanation of spouting geysers, hot springs, and earthquakes is also popularly traced to the supposed molten interior of the earth.

Until a few years ago scientists likewise would have expected to find a seething ocean of molten rock inside the earth—a central cauldron of lava still white hot from primeval fires. But today the scientist knows better. Today he knows that the earth is actually solid all the way through; that its interior is not molten rock at all, as most of us still believe, but a core of something more rigid than the strongest steel, probably a core of metal.

What Science Guesses

Just what that metal is, nobody knows for sure, but there are two especially interesting scientific guesses. Dr. William H. Hobbs, the distinguished professor of geology at the University of Michigan, guesses, for instance, that the earth has a center made up mostly of solid iron.

This sounds strange enough; but another theory—a more recent one—is much stranger still. "The heart of the earth," says this newer theory, "is a heart of gold!" At the very center of the globe there may be millions of tons of gold and silver and copper and platinum and the other heavy metals.

This is not mere fantastic speculation, but a sober deduction from the most critical

investigation ever made in the chemistry of the earth's crust—an investigation conducted by the acknowledged world authority on this subject, Dr. Henry S. Washington, of the Carnegie Institution of Washington, D. C.

Doctor Washington, studying over 5000 trustworthy chemical analyses of the crust of the earth, found that the elements common in the crust are exclusively those of lighter weight. The heavier elements occur only in the most minute proportions. Gold, for instance, composes less than one millionth of one per cent of the earth's crust!

Yet Doctor Washington thinks it improbable that these heavier elements were always lacking. Then where is Mother Earth's missing quota of gold, platinum,

and other heavy elements? Have they hidden themselves away out of our reach?

Doctor Washington believes that they have. He thinks that the earth was once molten. While it was in this condition the lighter elements rose to the surface; the heavier ones sank. He thinks that millions of tons of the missing elements are inside the earth now.

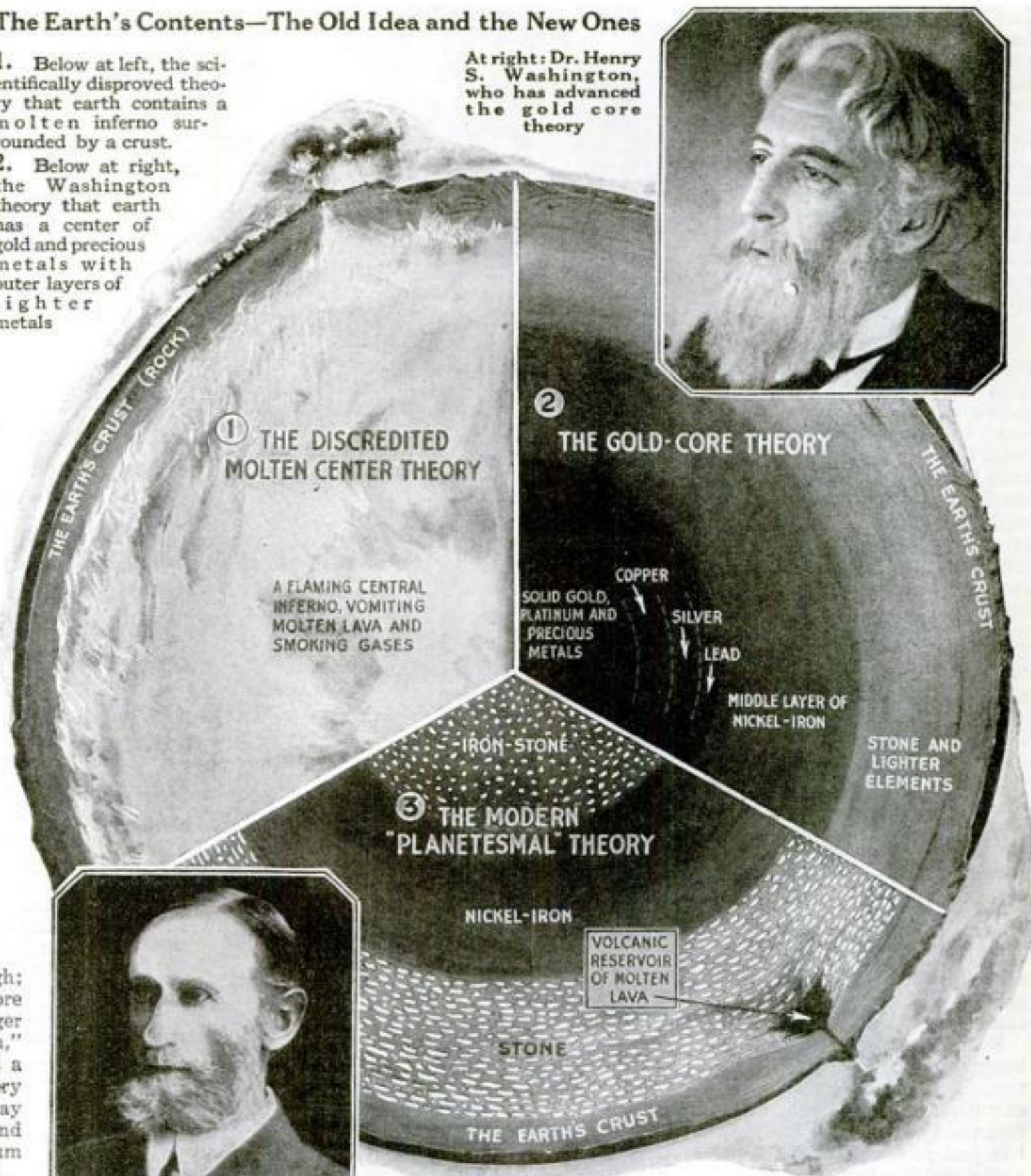
At the very center he would expect to find a core of the heaviest elements—such as platinum, gold, antimony, and osmium, the latter the heaviest known substance, familiar to us all in that natural alloy, "iridosmium," used for the tips of gold pens. Outside this sphere of precious metals there is, perhaps, a zone of those elements that are little less heavy—copper and silver and lead. If there is a zone of iron, as Doctor Washington

The Earth's Contents—The Old Idea and the New Ones

1. Below at left, the scientifically disproved theory that earth contains a molten inferno surrounded by a crust.

2. Below at right, the Washington theory that earth has a center of gold and precious metals with outer layers of lighter metals.

At right: Dr. Henry S. Washington, who has advanced the gold core theory



3. Above, the theory that the earth was built up of accumulating lumps of metal and stone. At left, Dr. William H. Hobbs, geologist, leading exponent of this theory

thinks there is, it presumably comes next. Clear outside, on top of all the metallic zones, is the surface layer of the lightest elements—the slag layer, the rocky crust on which we live.

If this is true, where do the veins of gold, silver, and copper that we mine in the earth's crust come from? The generally accepted scientific answer is that they have been brought upward by seepages of hot mineralized water from the depths of the earth.

Old Ideas Upset

But whether or not the earth's center is solid gold, it is certainly something heavy. It contains something far more dense than any of the rocks we know on the surface. And if you are astonished by this fact, which upsets most popular beliefs, you may be still more astonished by the way scientists arrived at it. They know the earth must have something heavy inside it because, for one thing, it weighs more than it should.

I can hear you ask, "What! Has the whole world been weighed?" Yes—the world has been weighed. Scientists have in effect put Mother Earth on the scales and found that she tips the beam at nearly six thousand million million millions of tons.

But how, you ask, did the scientists do it? Well, they started nearly 150 years ago with a novel experiment. It was an Englishman named Maskelyne who first decided to try to weigh the earth. To begin with, he decided he would need a mountain that he could use as a known weight for comparison. So he hired an engineer and sent him all over the British Isles to find a suitable hill. This engineer, as it happens, was that same Charles Mason who afterward became famous as one of the men who ran the Mason and Dixon line separating America's "slave" and "free" states before the Civil War.

Weighing the Earth

After a long search, Mason selected a hill in Scotland. Two plumb bobs, or weights hung on strings, were then set up, one on each side of the hill. Such a plumb bob normally will point straight downward toward the center of the earth. That is, it will point downward when it is on a level plain so that the only force acting on it is the gravitational attraction of the earth.

But when the plumb bob is hung up near one side of a mountain, it will not point exactly downward. The mass of the mountain will attract the plumb bob just as the earth itself does, and since the mountain mass is alongside the plumb bob and not below it, it will attract the plumb bob sidewise. In scientific lan-

guage, the plumb bob is "deflected from the exact vertical," and the amount of this deflection is proportional to the weight of the mountain as compared with the weight of the earth.

Because of this fact, Maskelyne's two plumb bobs were deflected very slightly,



Vesuvius in a recent eruption, showing flying masses of white-hot molten rock hurled from the exploding cone

each one toward the hill. Careful borings into the hill determined the average weight of its rock and this together with detailed surveys permitted the calculation of the hill's total weight. Knowing the latter, and the deflection of his plumb bobs, Maskelyne was able to calculate the earth's weight.

By modern scientific methods the earth

has been still more accurately weighed, but Maskelyne's results were reliable enough to prove that the earth was far too heavy to be hollow or composed of ordinary rock, since ordinary rock weighs only about two and three quarters as much as water, while the earth as a whole was found to weigh five and a half times as much as water. Therefore the inside of the earth must be made of some heavier material than the outside, and scientists today agree that this material is probably a metal or a mixture of metals.

Another thing that scientists agree about today is that this metal core of the earth is not molten.

The Molten Earth Idea

The idea of a molten earth originated, I suppose, from what men knew about volcanoes. When they saw molten rock burst out of the earth, they naturally thought that there was a vast reservoir of molten rock inside. Moreover, the once generally accepted "nebular hypothesis," concerning the origin of the earth, implied that there had been a time when our planet was a glowing liquid ball, and that it had gradually grown cold and hardened on the outside, leaving a fiery core within. But the nebular hypothesis doesn't agree with many unquestionable facts that we know

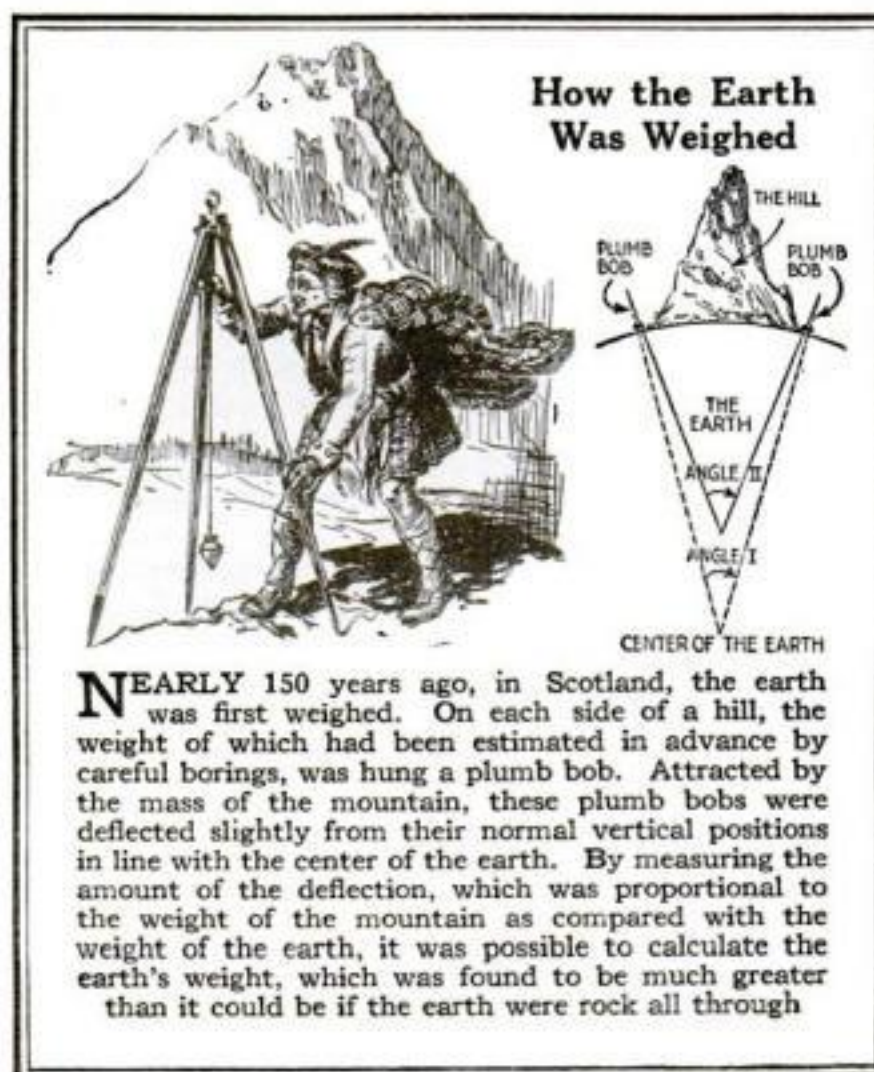
today; while volcanoes are explainable, as we shall see, quite otherwise than as giant chimneys from a huge inner furnace.

At the same time scientists have been learning other facts that disprove the theory of a molten earth. It has been found, for instance, that earthquake shocks move through the earth as they would through a rigid body. Furthermore, the spin of the earth obeys the mechanical laws characteristic of a spinning solid ball, not of a liquid one. And, most convincing of all, are the facts about the tides.

Earth Resists Tidal Pull

More than 50 years ago the great English scientist, Lord Kelvin, pointed out that an earth consisting of a thin solid crust surrounding a liquid interior would never be able to withstand the tidal pull of the sun and the moon. It is this pull of the heavenly bodies that makes the tides in the ocean. Now the pull is just as strong or stronger on the land. Why, then, are there not tidal waves in the solid ground as there are in the sea? Obviously, just because it is solid—because the land is too firm and rigid to yield to the tidal pull the way the water does.

Lord Kelvin figured out in tons the amount of these tidal pulls on the land. They were stupendous; many times larger than any possible resisting strength of the 50 or 60 mile crust then supposed to





Flaming Lava at Night

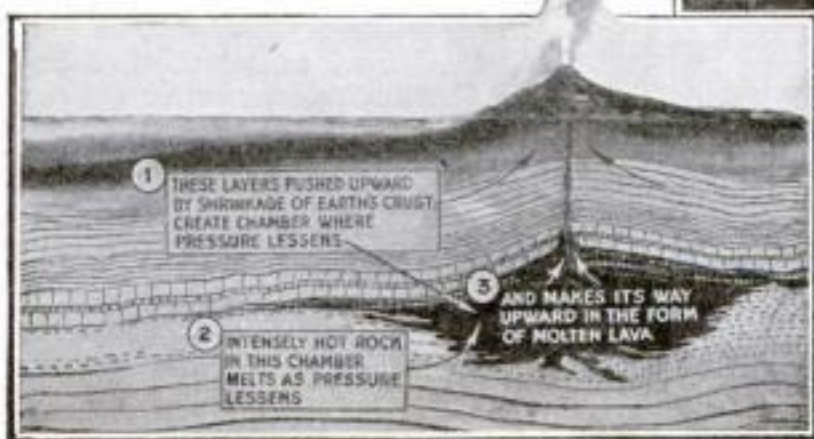
THIS remarkable night-time photograph of the flaming new cone of Mount Vesuvius, taken from the floor of the crater by Frank A. Perret, head volcanologist of the Smithsonian Institution, shows vividly a typical display of volcanic fireworks in the course of the mountain's recently renewed activity

constitute the only solid part of the globe. If we tried to live really on a thin rocky crust floating on a sea of liquid lava, we should not last one day. Inside of 24 hours the solid ground would smash under our feet. Twice each day a vast wave of melted rock, hundreds of feet high, would roll round inside the shell of the earth, bursting through it and overwhelming every vestige of anything solid.

There actually does exist, it is true, in the land as well as in the ocean, a tide; but it is a few inches high instead of hundreds of feet. It is the kind of tidal rise and fall that would happen in a very rigid solid—not in a ball of crusted liquid. We may be quite sure, then, that the earth as a whole is a huge solid ball, even more rigid than if made of the best steel clear through. If it was once molten long ago, as Doctor Washington believes, it must have cooled in the course of ages until it has become solid all the way through. But it is possible, on the other hand, that it never was molten at all, that it has always been as solid and rigid as it is now.

This view Professor Hobbs has lately brought out in his book, "Earth Evolution and Its Facial Expression," though he prefers the word "rigid"

(Continued on page 30)



How Vesuvius Became a Roaring Smokestack

IN SUPPORTING the theory that the earth is a rigid sphere, with center of solid iron and rock, Dr. William H. Hobbs offers an entirely new explanation for volcanoes (see diagram at left). He suggests that shrinkage of the earth, pushing surface rocks upward into mountain ranges, forms low-pressure pockets compara-

tively near the earth's surface. With reduction of pressure the intensely hot rock in the pocket melts, and the molten rock rushes to the surface wherever it can, forming flaming volcanoes.

In the photograph above, scientists on the crater floor are shown measuring the temperature of the gases escaping from the lava

Threadless Wrench Holds Fast in Tight Places

WIDESPREAD demand for an end wrench that will adjust instantly and stay adjusted until the nut is loosened, has led to the perfection of a postless, screwless, and threadless de-



Thumb pressure engages or releases the teeth. Handle forms lower jaw

vice that combines light weight and great strength. In designing this wrench the manufacturers have eliminated all excess bulk in the head, thus making it possible to use it in tight places.

The handle forms the lower jaw and is notched at right angles to the gripping face, while the movable upper jaw is also notched and can be moved up or down when the notches are pulled out of engagement. When the thumb of a hand holding the wrench presses the corrugated part of the movable jaw, disengaging the teeth, the upper jaw will move instantly up or down to the proper adjustment. Pulling back on the jaw with the thumb again engages the teeth.

What Is Inside the Earth?

(Continued from page 29)

to the word "solid," for rigidity is only one of the properties of solids. Under the tremendous pressure and temperature inside the earth, it is possible that the properties of matter are not the same as we know them on the surface. Things may be "rigid" and still lack some other property of "solids." Professor Hobbs explains the origin of such a rigid earth among the blazing, gaseous stars of space by reference to a new theory of how the earth was formed—the so-called "planetesimal hypothesis."

This hypothesis begins by imagining the sun as a single star, a little larger and hotter probably than it is now. There were no planets sweeping around it then. Along came another star. It happened to pass so close to the sun that the gravitational attraction between the two bodies pulled out a lot of matter from the sun.

These enormous pulled-out "drops" of matter began to revolve about the sun. In time, as they collided with one another, sticking together when they struck, they gathered into great lumps. These lumps are the planets we know today—Venus, Mars, and the others; also the earth.

Explaining the "Planetesimal" Theory

The visiting star left behind a sun surrounded by a vast revolving cloud of matter that had been torn out of it.

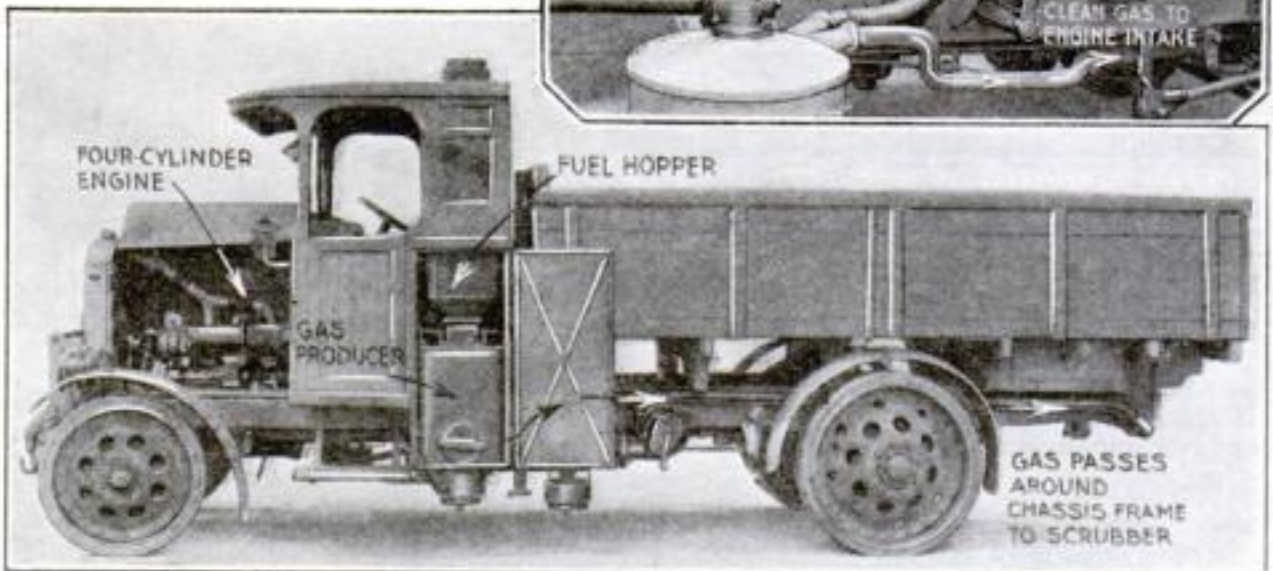
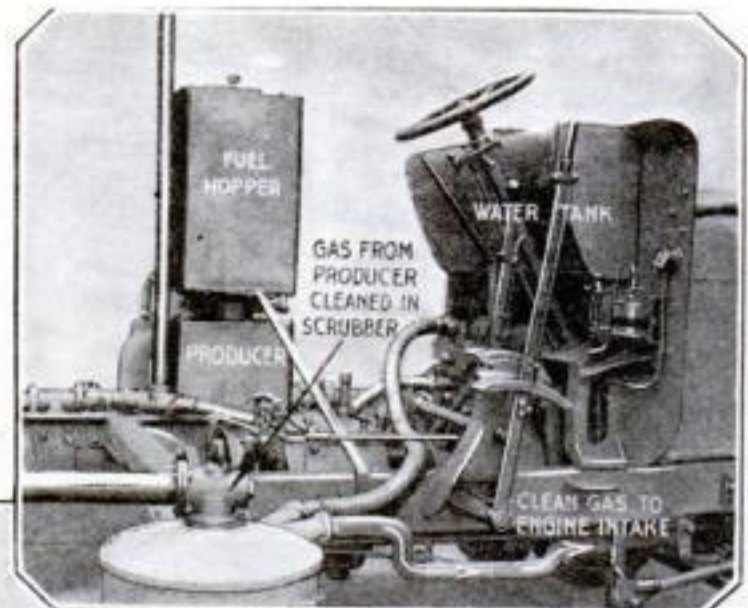
In this cloud were millions of small lumps of matter—called "planetesimals," or baby planets. One of them, a little larger than the others, became the nucleus of our earth. It picked up the smaller lumps that happened to be revolving about the sun in the same general path. Think of a molasses-coated baseball flying through an endless swarm of gnats.

In the course of time—millions on millions of years—the earth picked up nearly all the baby planets within its reach.

Motor Truck Runs on Coal or Corn

TO BEAT the rising cost of gasoline, British manufacturers have perfected a motor driven by gas formed by blowing a steam jet through a bed of burning coal, charcoal, or corn, or any material rich in carbon, and generated while the vehicle is in motion.

Heat from the fuel produces steam, which is then forced into the firebox. Carbon monoxid gas is a result. This gas is admitted to the engine cylinders.



The new producer gas truck, showing engine, generator, and fuel hopper

That is the condition now. A few small bits of matter, which managed to escape before, are still being picked up occasionally. These are the meteorites that we see shooting over the housetops at night.

World Built by Meteors

Now scientists who are studying these meteorites that still arrive on the earth, note that they are of two kinds. Some are iron and some are stony. The latter consist of rocks much like the rocks on earth.

Of the vast original cloud of matter pulled from the sun, Professor Hobbs—whom I mentioned above as the most recent advocate of the iron-core theory—thinks about half consisted of iron lumps like these iron meteorites, and about half of rock lumps like the stony ones. They were continually hitting each other like grains of sand in a storm. From mathematical calculations, the professor concludes that the larger lump that was to become the earth would pick up at first a pretty fair average of smaller lumps, about as many iron ones as stony ones. A little later, when the crowd had been thinned somewhat, it would pick up mainly iron lumps. Later still, it would pick up mainly stony ones, as the earth is doing today—for iron meteorites now are rare.

You can see what sort of structure the earth would have under this theory. At the very center is the original nucleus; next is a zone of half iron and half rock; then comes a zone that is almost pure iron; and the outside is a rock zone—the visible crust of the earth today.

But the theory, as it stands, seems to leave us still mystified about those fiery, death-dealing smokestacks of the earth—the volcanoes. In scores of places on the earth's surface, millions of tons of melted rock are still being hurled out from the earth's interior. Whence comes all this fire and steam and molten stone?

Professor Hobbs answers with an entirely

new explanation of volcanoes. He says that volcanoes are caused by a sudden melting of a small pocket of rock comparatively near their surfaces.

To begin with, the inside of the earth, while not molten, is known to be intensely hot. Even at a depth of only 50 or 60 miles—less than one eightieth of the distance to the center of the earth—the rocks are so fearfully hot that they would melt at once if it were not for the tremendous pressure of the mass above them. This pressure keeps the heated rock from melting, just as the pressure in a steam boiler keeps the water from all flying off as steam.

Rocks Melt as Earth Shrinks

But if you open the top of the boiler and relieve the pressure, the water will all fly off as steam. And similarly, says Professor Hobbs, if you pry up some of the outer layers of the earth's crust, thus relieving the pressure on the hot rock inside, this rock will promptly melt. Now the earth is constantly—if very slowly—shrinking in size. As it shrinks, the surface rocks are pushed up into folds and wrinkles like the wrinkles on a dried-up prune. These become mountain ranges. Under each of them the weight of the rock is lifted a little, the pressure on the deeper rocks is decreased, and these rocks quickly melt. Whenever it can, this melted rock finds its way out to the surface and a new volcano is born.

Thus, whether we accept the iron core theory of the earth's interior, or the new gold core theory, we may at least go about our affairs on earth secure henceforth in the belief that we have the solidest conceivable footing underneath us; and that the awe-inspiring outbursts of volcanoes are merely local accidents instead of being, as people once thought, the grim mutterings of some vast, fiery inner cavern lurking right below our feet and threatening in some monstrous future catastrophe to engulf us all.

"The Story of Man and His World"

The Most Fascinating Serial Ever Published in a Magazine

YOU will read in POPULAR SCIENCE MONTHLY during 1923 the most important serial ever published in a magazine. You will enjoy the most fascinating and thrilling story that could be told. It is a tale more absorbing than fiction could ever be. *And every word of it is fact!* It is "The Story of Man and His World."

It Begins in the Next Issue of Popular Science Monthly

THIS unique serial, by Dr. E. E. Free, tells the marvelous romance of life itself. It is Science's own story of how our world came into being, of how life appeared and developed upon it, and of how the amazing drama of Evolution led, at last, to the birth of Man. It is a story of spectacular events that covered more than a thousand million years—a time so vast that all the centuries of recorded human history are "but a few seconds" beside it.

Never before have you been able to read this wonder story of "Man and His World" in one simple, continuous narrative. Dr. E. E. Free—scientist, traveler, engineer, and one of the best writers of popular science in America—has revealed, in words made plain for everybody, the great secrets of science and life hitherto beyond the grasp of the average man.

ACROSS the pages of this great serial march prehistoric lizard-like monsters—twice as tall as elephants, more terrible than the fiercest tigers. And dodging fearfully beneath their feet run a few tiny, ratlike creatures destined to outlive the freak monsters they fear and to become the ancestors of nearly all modern animals, including man himself.

In a still more ancient scene of the story you will see a tiny "wormlike thing" trying to make his way up the bottom of a river against the current, trying patiently generation after generation, century after century, until he finally "invents" something that enables him to succeed—a rod of gristle down his back. What did he do, this little striving worm of five hundred million years ago? He invented the backbone, one of the greatest of all steps in the evolution of man!

Still farther back, in the dimmest mists of time, you will see a world absolutely devoid of any life except tiny pear-shaped drops of jelly with hairlike stems. These, you will learn, were the first ancestors of all life.

Facts You Need to Know

How much of this story do you know? Can you afford not to know more of it, if you are to call yourself well informed in this Age of Science?

Do you know that once there was an insect-eating ancestor of man who looked about half like a dog and about half like a cat? Do you know that in far off Madagascar there still dwell descendants of this humble "cat-dog" creature? Or do you know how the marvels of the human body develop from a single speck of living matter, a single cell so small that you can see it only through a powerful microscope? Do you know that certain similar one-celled things live always inside our own bodies as separate creatures—the white blood corpuscles that attack and eat disease germs?

Innumerable fascinating facts like these go into the making of Doctor Free's great story. It is a magnificent panorama of science.



Above: Our world in its infancy, perhaps ten billion years ago—a huge, flaming, lifeless ball, and below, some of the spectacular characters from Doctor Free's great story of life on earth



Above: One of "Nature's jokes," from the "Age of Reptiles." Below: The most terrible creature that ever lived—*Tyrannosaurus Rex*



Below: The woolly mammoth, a contemporary of prehistoric man



Below: The earliest known human form, the Ape-man whose bones were found in Java



At right: The gorilla, man's nearest animal cousin



Don't miss this wonderful story, which begins in our next issue

Deep Sea Thrillers in Natural Hues for the Movies

Gorgeous Life on Ocean Floor to Be Thrown on the Screen

ALL our ideas of the bottom of the sea as a dark, colorless dungeon are now to be dispelled, with the announcement that J. E. Williamson, famous creator of undersea movies, is considering plans to use when possible the new color movie process perfected by Dr. Daniel Frost Comstock in photographing in all its gorgeous colors the little known animal and plant life dwelling in shallow waters below the ocean's surface.

An Undersea Pioneer

Williamson, the one motion picture producer who has invaded the ocean floor, already has recorded on black-and-white films many wonderful and thrilling marvels of submarine life that are entirely new and strange to us. Now, when color films are perfected, he is satisfied that even those of us who know in a general way what the bottom of the sea looks like will gasp in amazement when we see the natural brilliancy of those mysterious depths—the "land" where plants flourish, flowers bloom, and undersea life flashes in all the colors of the rainbow.

Williamson has made thousands of daring voyages to this land, particularly in the vicinity of the West Indies. He knows its out-of-the-way places. For the black-and-white movies he has staged there thrilling scenes before the camera—battles between divers and man-eating sharks, adventurous searches for sunken treasures, and "mermaids" frolicking through deep sea forests.

Men and Camera Dropped into Ocean

An artist and newspaper photographer, Williamson first utilized an invention of his father's to take movies under the surface of the water. This invention consists of a steel, glass-faced, watertight chamber in which it is possible for a photographer to operate a movie camera. By means of flexible sections this chamber is lowered from a vessel to great depths. Overcoming hundreds of difficulties, Williamson produced the first undersea movie—"The Williamson Submarine Expedition"—and later Jules Verne's "Twenty Thousand Leagues Under the Sea." His latest exploit was to film with the slow camera the swift movements of man-eating sharks and other undersea inhabitants.

When color movies can be applied to the sea depths, he says that:

Islands of coral, which until now have appeared on the screen as gray masses of beautifully shaped plant and tree formations, will be reproduced in their natural colors—blues, pinks, and reds. Deep sea mosses and ferns will be seen in gorgeous greens. We shall see fishes of all shades and forms—the brilliant weakfish, the pink pompano, the variegated moonfish, angel fish and sailfish, the mottled tarpon, the chameleon-like moray, which

New Color Photography Will Show Strange Plants and Fishes

changes its color like tricolor silk, and the monster gray shark.

All this we shall see in a glow of spectral bluish light that illumines the ocean depths.

The remarkable results of the first successful color movie process are fully explained for the first time on page 59 of this magazine.



Marvelous new underwater photographs taken by J. E. Williamson off the West Indian islands. They show divers attacking some monster of the depths; a "mermaid" gathering "flowers" in a garden on the ocean floor; gorgeous forests of living coral, hiding strange, many-colored inhabitants



How J. E. Williamson photographs thrilling scenes at the bottom of the sea, operating his movie camera in a watertight, glass-faced chamber, lowered from a vessel at the surface. Great depth is obtained by means of a flexible and collapsible tube supported by steel rings

Staging a Deep Sea Film

A thrilling battle with a man-eating shark at the bottom of the sea is pictured here as it will be shown in the proposed new under-

sea color movie. Williamson has actually photographed a similar battle for black-and-white movies now being shown

Seven-Ton Retort Scrapped by High Explosive

THE use of high explosives to scrap bulky and unwieldy iron receptacles or machines that have been discarded is replacing the cumbersome method of lifting them entire on cars and hauling them away to be melted.

The scraps into which the receptacle or machine is shattered by the blast are not only easier to load on cars, but they also take up less room and thus conserve car space.

A manufacturer of explosives recently demonstrated this method of reducing useless iron receptacles to scrap. A seven-ton nitric-acid retort, six feet high, was filled with water and six quarter-pound charges of 60 per cent explosive gelatin, fitted with electric detonators, were suspended in the water.



Setting the charge. Into the seven-ton retort, filled with water, are dropped six small charges of explosive gelatin



The explosion. Much of the force of the charge spends itself in the form of a towering geyser

When the charges were fired, a huge geyser of water rose from the shattered retort, while the fragments of the vessel fell within a radius of only 25 feet. The factor responsible for confining the flying fragments to such a limited space was the water that filled the retort and in which the explosive was placed, for this reason:

Water is practically incompressible. Therefore, when the gelatin was exploded in the water, the expansion was instantly transmitted to the sides and bottom of the retort in sufficient force to crack them into pieces. But since the top of the receptacle was open, the greater part of the explosion force spent itself upward, producing a tall geyser of water. The shattered fragments of the receptacle, on the other hand, fell only a few feet.



The remains. Fragments of the shattered retort, confined within a 25-foot radius, are easily loaded on cars

Engineers Make Mississippi River Bed Autograph Its Profile

AN AUTOGRAPHIC sounding machine that makes it possible to obtain a detailed and accurate profile map of a river bottom as rapidly as a tow-boat pulling a barge can move along the line of soundings, has been developed by M. Meigs, Corps of Engineers, U. S. A., and is being used by government engineers to chart snags, shoals, and rocks on the upper Mississippi River.

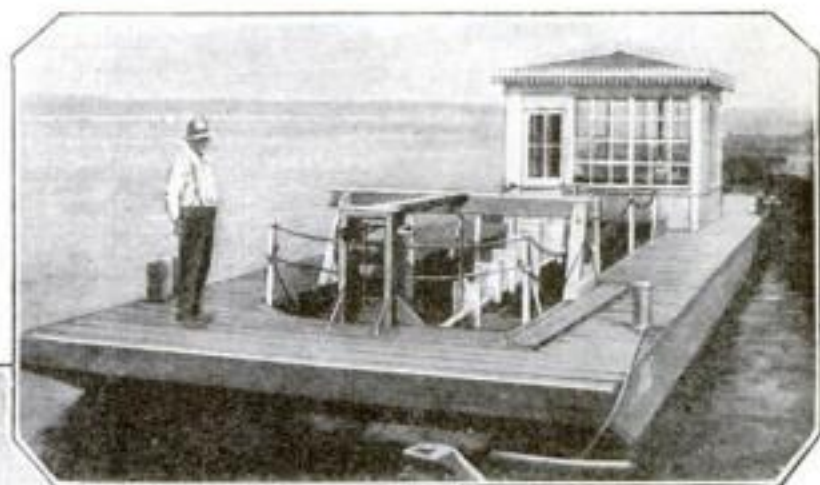
The essential part of the mechanism is a sounding arm, the lower end of which drags along the bottom of the river, following the contour of the river bed. The upper end of the arm is connected with a recording device located on a barge. Vanes attached to

the arm oppose the water in such a way as to force the end of the arm down to the river bed.

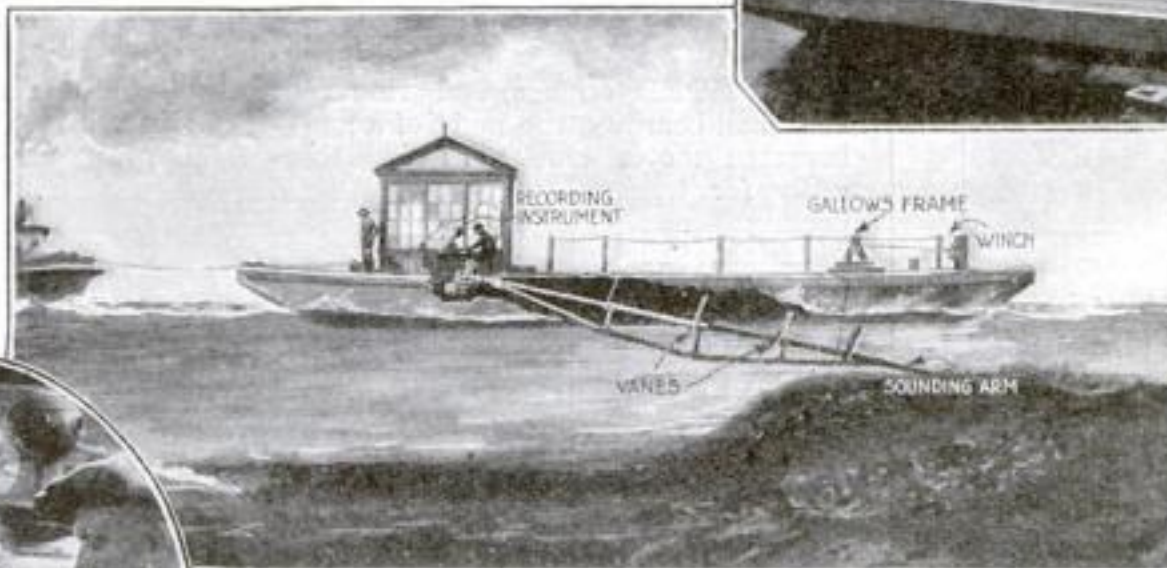
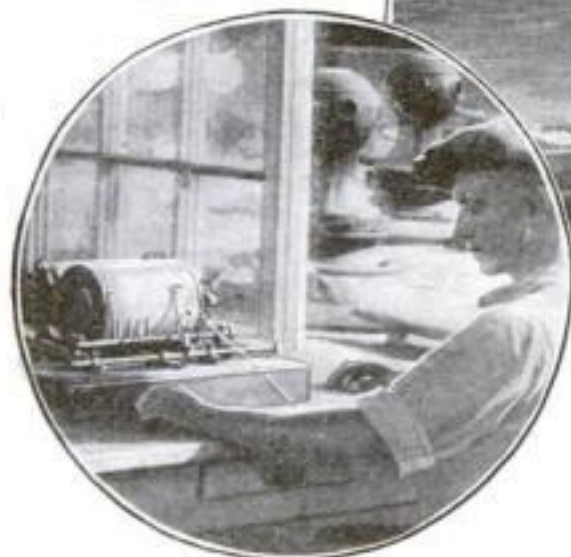
As the barge, equipped with sounding arm and recorder, is towed along the river, any elevation or depression of the river bed causes the arm to move through angles corresponding to changes in elevation. A quadrant attached to the upper end of the arm moves through an equal angle and this motion is transmitted by a thread to the recorder. Here a stylus marks on charting

of the barge, the stylus produces a jagged line along which horizontal distances indicate miles covered, while vertical distances indicate elevations of the river bed.

A valuable feature of this mechanism is



As the barge is towed along a river, every movement of the sounding arm, following the contour of the river bed, is transcribed on charting paper by a stylus. The recording instrument is shown below



Above is shown the barge, equipped with sounding and recording mechanism used by government engineers in making profile maps of the river bed along the upper Mississippi. The operation of the machine is shown at left. Note the vanes that steady the lower end of sounding arm on the river bottom

paper the amount of movement of the thread. By means of a graduated scale, every change in the distance of this mark from a base line can be interpreted as indicating a definite angular displacement of the sounding arm and hence a definite change in elevation of the river bottom.

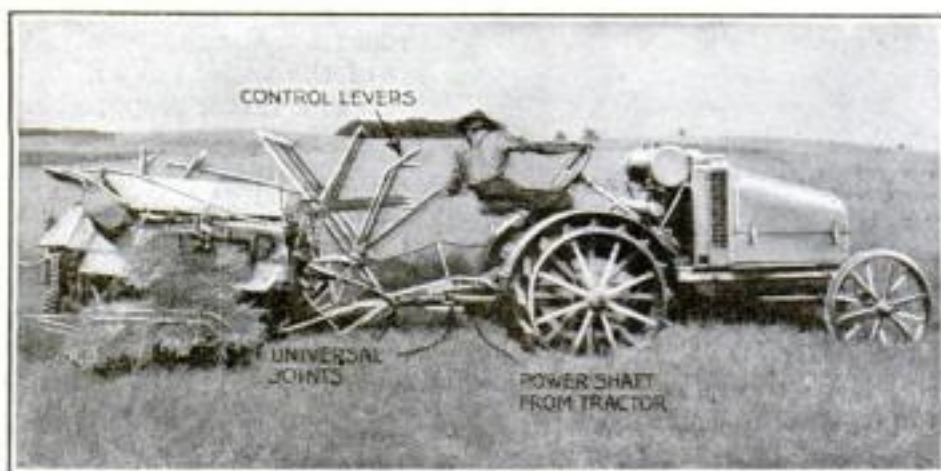
Since the recording paper is moved across the stylus at a rate corresponding to the speed

that the nature of the river bottom is also recorded. Gravel, sand, mud, rock—all reproduce their peculiar handwriting on the chart.

Hidden snags are also revealed; dangerous boulders are located. Indeed, the complete record of the river bottom on which the sounding arm is dragged, is obtained on the recording strip of paper.

Tractor Drives One-Man Grain Binder

OPERATED by one man, a new power driven grain binder, developed by a Chicago implement manufacturer, cuts a 10-foot swath and harvests from 30 to 35 acres a day. It is said to mark the greatest step since the invention of the binder in the seventies.



Through a revolving shaft with universal joints, power is delivered from the tractor to the binder that it hauls

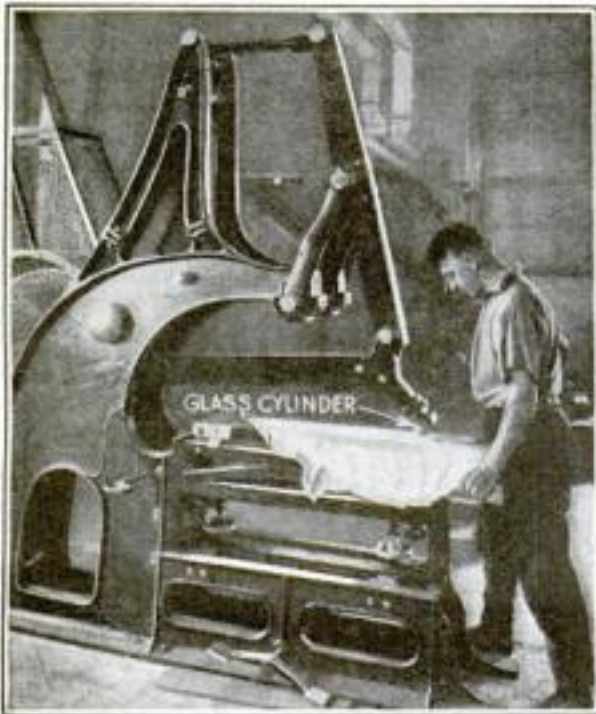
The machine differs from other binders in that the power for operating the binder mechanism is derived, not from the main wheel, but from the tractor that pulls the binder. This power is delivered from the tractor by means of a revolving shaft with universal joints that make it possible to cover very rough ground. The arrangement enables the binder to be run at more uniform speed, and the steady flow of power from the tractor makes it possible to cut a wider

swath than with the ordinary binder. The direct positive drive prevents slipping and choking where conditions for cutting are unfavorable.

Should the binder become choked, it is necessary only to stop the tractor. The power drive continues to operate the binding mechanism and the binder automatically clears itself. It is claimed that the machine doubles the acreage that can be harvested by one man, greatly increasing his efficiency.

How Rough Hides Become Glossy Leather

THE process by which the raw hides of animals are transformed into leather is far more complicated than most people realize. After the hides reach the tannery, they are cleaned of blood and dirt and then softened by soaking and mechanical treatment. Then the hides are treated with



Pressed under a moving glass cylinder, the leather receives its glossy finish

Heavy leathers are usually ready for the market after they have been tanned and have been through the subsequent "currying" process, but the light leathers are often dyed, stained, grained, or embossed before they are marketed. Slow working acid dyestuffs and direct cotton dyes are the most satisfactory. The leather is either dyed in a manner similar to the dyeing of cloth, or the dye is applied to the surface with a brush.

Some leathers retain the rough dull finish with which they come from the dye bath; others are given a smooth and glossy finish. This is done with a machine such as that shown in the illustration. The leather is placed on a bed, and is pressed against a glass cylinder, which is run back and forth over the leather with considerable pressure. This completes the process.

lime, by which, with the aid of bacterial action, the hair is so decomposed that it is easily scraped off, together with the skin. At the same time the "net skin" on the flesh side of the hide is removed by scraping and shaving.

After the hides are "dressed," they are "scudded," a process of scraping to remove lime, hair, flesh particles, pigment cells, hair sacs, and soluble hide substance. Concluding with a thorough rinsing, the hides are ready for the tanning process, which varies according to the kind of skin and the purpose for which the leather is to be used. Having gone through the tanning process, the hides are scoured and then oil and grease are worked into the skin.

Bread Loaves Measured to Standard by Seeds

HOW Uncle Sam is continually on the alert to prevent you from being "short weighted" when you purchase food is shown by the recent adoption of a bread measuring device by the Bureau of Agricultural Economics.

The displacement principle is employed, the volume of a particular loaf of bread being measured by the uniform flow of flaxseed into a graduated tube. The bread is placed in a container and the flaxseed is allowed to flow around it, completely sur-



© Harris Ewing

By the uniform flow of flaxseed in this apparatus, Uncle Sam measures the size of loaves

rounding the loaf and filling all the crevices almost as completely as would water. The difference between the amount of seed required to fill the container when the bread is in it, and that required when the bread is removed measures the volume of the loaf.

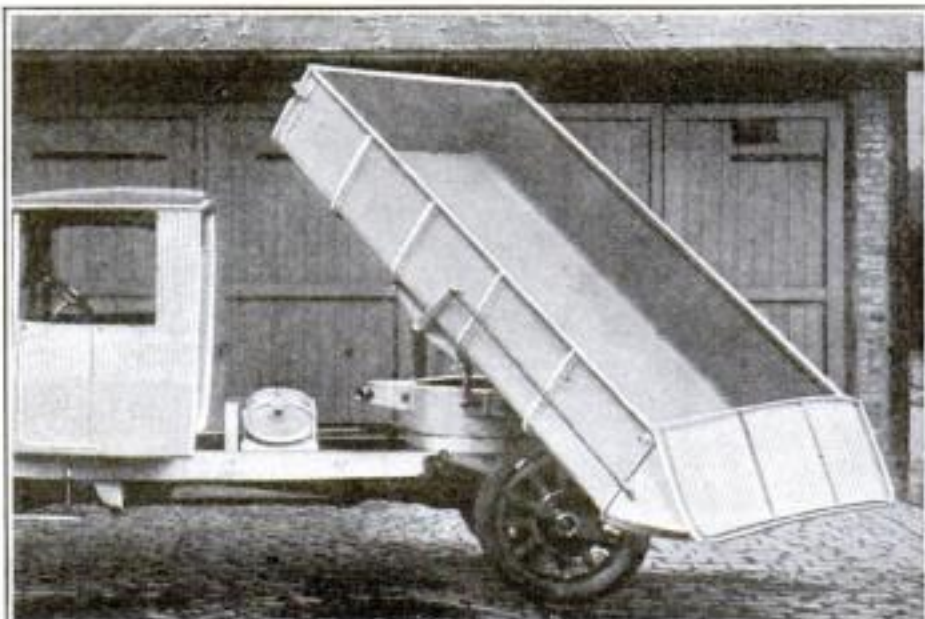
The flow of seed into a funnel below the container measures in cubic centimeters.

Dump Truck Has Swiveled Tilting Body

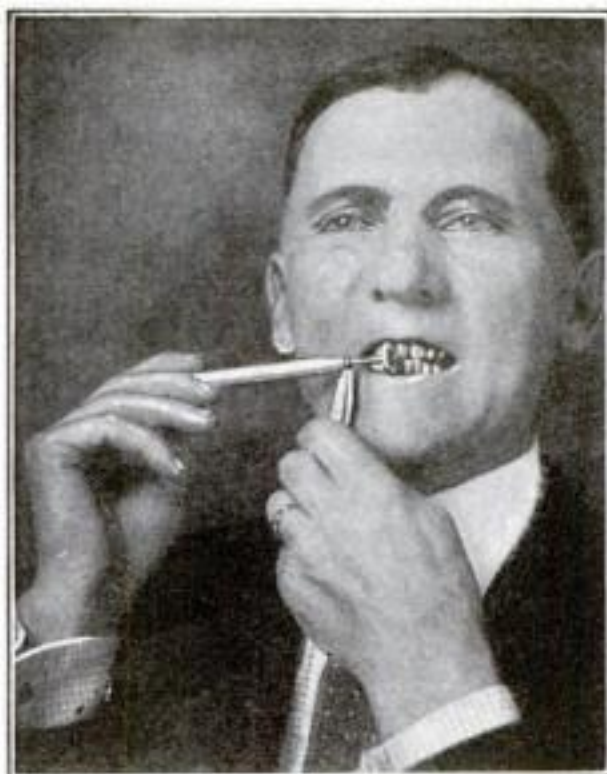
MOUNTED on a swivel ring with ball bearings, the body of a newly invented motor truck, designed especially for transporting heavy materials, such as coal and rock, can be rotated so as to discharge its load either backward, on either side, or in any direction between these angles. The capacity of the body is 5½ tons.

The ring mounting is equipped with a gear for tilting the body for discharging its load. The gear for op-

erating the swivel and for tilting the body is driven by the gasoline engine that propels the truck.



This swiveled body can be tilted in any direction



Rotary Brush for the Teeth

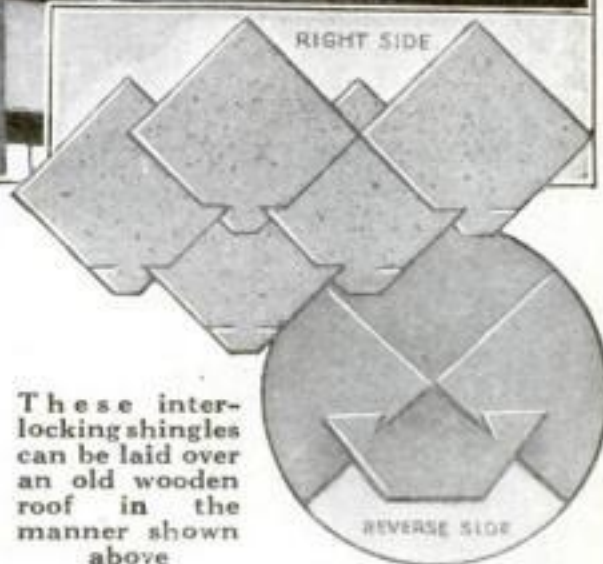
MORE thorough cleaning of the teeth is made possible by a small circular brush rotated by turning the sanitary handle to which it is rigidly fastened. The position and pressure of the brush on the teeth are maintained by a second handle through which the shank revolves.

New Shingles Interlock over Old Roof

INTER-LOCKING asphalt shingles which, the manufacturers claim, will not warp, curl up or blow up in wind or storm, have been designed especially for reroofing old wood shingle roofs without the necessity of tearing off the old shingles.

The interlocking feature permits single-layer roof construction.

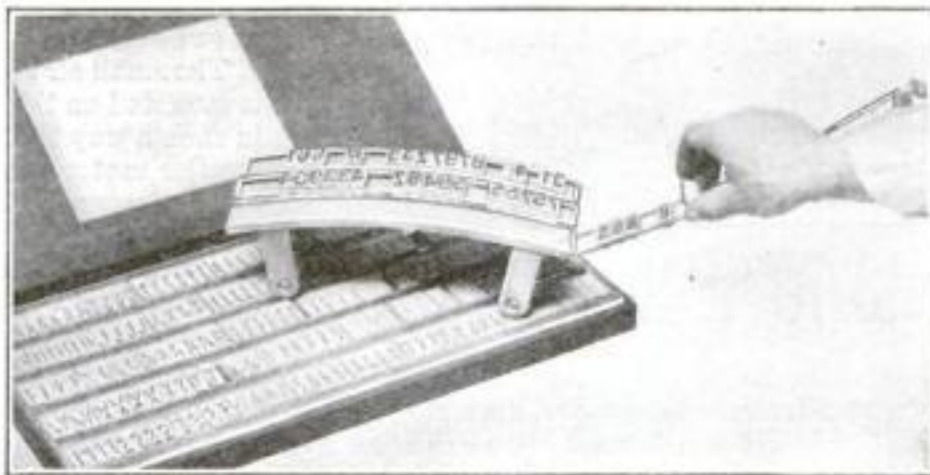
Interlocking of these shingles is accomplished by means of slits cut in both sides of each shingle two inches above the butt, as illustrated at the right. Into these slits fit the edges of adjacent shingles. Tab points formed by the slits lock tightly on the under side when the shingles are nailed down. The shingles are made in various colors.



Type Setting Made Easier

A RUBBER stamp printing outfit by which the operator can set type without having to read the letters or figures backward has been perfected by a San Diego, Calif., manufacturer.

The type units are placed in a hinged wire frame that forms the face of the stamp. This frame is swung away from the face and in it are placed



the type units, on which are printed the letters as they will be read.

Safety Fender Puts Brakes on Descending Elevator

AN AUTOMATIC safety fender for freight elevators has recently been devised by a large manufacturing concern to safeguard operators from being crushed to death by descending cars.

The invention consists of a control bar attached beneath the floor of the car and connected with the elevator driving mechanism in such a way that the instant



Striking a workman's head, the fender bar automatically brakes the descending elevator

Tractor Elevator Loads a Ton a Minute

A PORTABLE elevating loader, operated by and mounted on a Fordson tractor, is a recent contribution to industry by a Philadelphia, Pa., manufacturer. At-

tached to a regular Fordson tractor and taking its power from the power shaft of the tractor, the loader is said to elevate and load more than a ton of material a minute.



Illustrating how the conveyor is attached to the tractor

The material is picked up and elevated by buckets attached to an endless chain and is dropped upon a conveyor that runs in a trough over the top of the tractor. This conveyor drops the material into trucks drawn up in front of the tractor. The tractor backs into the pile of material to be loaded so that there is a continual supply for the elevator.

the bar strikes any obstruction it automatically shuts off the power and brakes the car.

Thus if a workman should be leaning over the shaft door with his head and shoulders in the shaft, the safety bar of a descending elevator, striking his head, would immediately brake the car and bring it to a stop before the pressure could become great enough to crush him.

Charting Mouths with Dummy Teeth

BY THE use of dummy teeth mounted on an aluminum plate, dentists are now able to chart quickly the conditions found in the mouths of their patients and

© Izzy Kaplan

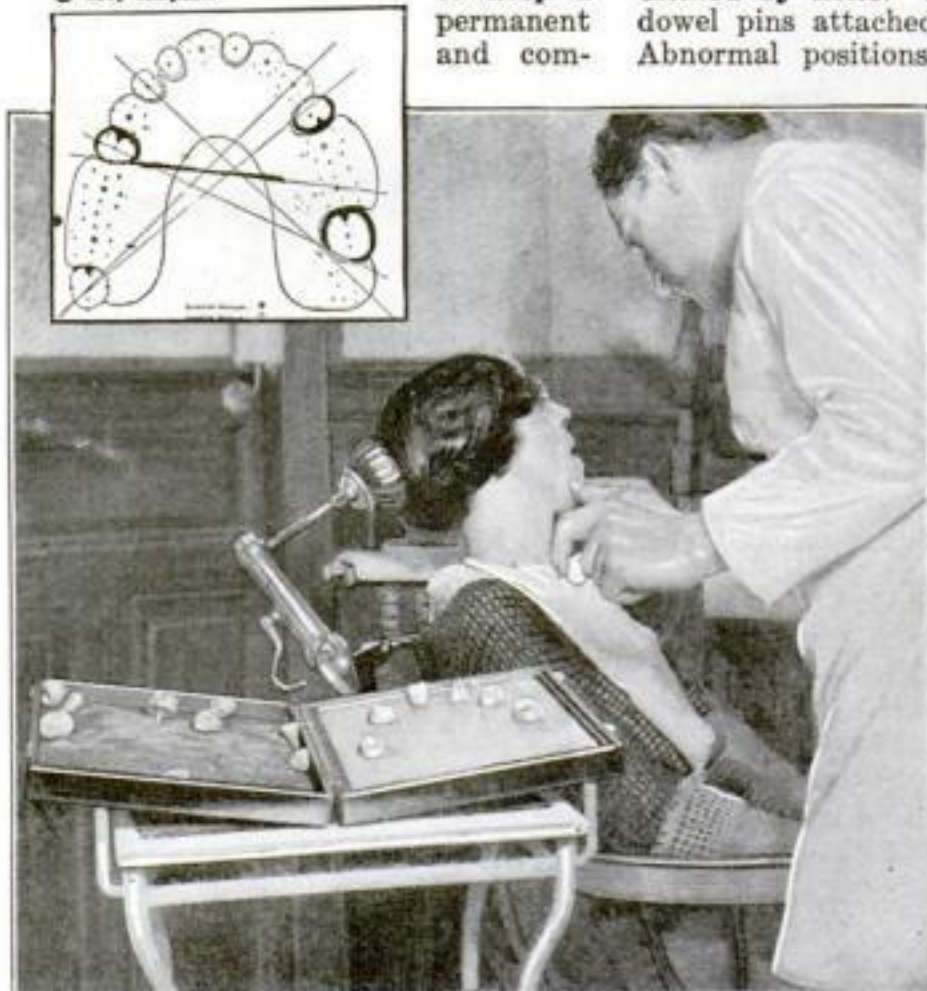
to keep a permanent and com-

plete record of every case treated.

On the plate is marked a diagram of a normal dental arch. The normal positions of the 16 teeth of each jaw are indicated by holes. Into these holes fit dowel pins attached to dummy teeth. Abnormal positions of the teeth are

reproduced by inserting the dowels of the model teeth in other holes provided for that purpose.

A permanent record of each case is made on charts on which the position holes of the planning plate are marked. To make a record, a chart is placed on the plate so that the dots coincide with the holes. Then the dowels of the dummy teeth are inserted into the respective holes through the chart. The chart is then filed for future reference that will save much time.



The inset above shows a typical permanent chart of a patient's teeth, made by means of the dummy teeth

Slide Rule Makes Radio Calculations

THE recent invention of a circular radio calculator or slide rule, by Raoul J. Hoffman, noted aeronautical engineer of New York City, has assisted greatly in the design of wireless sets, eliminating the tedious method of computing values for inductance, capacity, and other necessary figures by means of formulas.

The calculator consists of a cardboard base, on which are mounted a circular cardboard dial and transparent celluloid pointer, and has in all, 29 scales graduated in the units used.

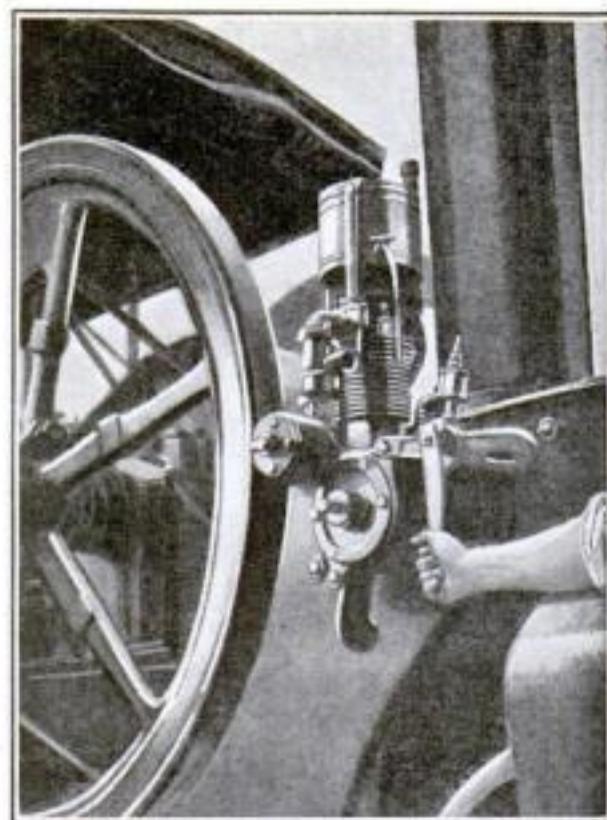
Thus, to compute inductance of a coil 4 inches long, 5 inches in diameter, wound

with No. 20 double cotton covered wire, the two scales of length and diameter of the dial and base respectively are adjusted so that the proper figures are superimposed. The celluloid pointer is then moved to DCC 20 and the answer, 2700 microhenrys, is read on the dial.

Vice versa, if the inductance were known, the coil dimensions could be determined.



Radio calculations are made by adjusting circular dial and celluloid pointer



Small Gas Engine "Cranks" Large Road Roller

USING a small single cylinder gasoline engine to start a large one, a concern in Harvey, Ill., claims to have solved the problem of turning over the crankshaft of a large road roller engine. Heretofore electric motors and compressed air starters have been used.

The small air cooled single cylinder motor is mounted on the frame of the larger engine in such a way that the friction pulley of the smaller motor presses against the flywheel of the larger engine. The operator starts the small engine by hand, and then by pressure on a lever, brings the small wheel in firm contact with the large one. As soon as the large motor has started, the smaller engine is stopped.

OFFICIALS of the Bureau of Animal Industry say that there were twice as many cases of rabies during the year ending June 30, 1922, as the year before, and point to the fact that many of the cases occurred during the seasons when dog-muzzling is not required by city ordinances.

Civil War Sniper's Rifle Comes Back

THE sniper's ponderous rifle of Civil War days has returned in the form of a super-accurate rifle made by the Winchester Arms Company for the United States Government and used by the 1921 Olympic team in defeating the Swiss riflemen for the first time in a score of years. The Civil War weapon was used only for sharpshooting, for it was so heavy that it had to be transported in a wagon and shot from rest. The barrel was made unusually heavy to overcome the whipping action or "jump" of the gun.

In 1915, Captain William Richard, one of the world's greatest riflemen, conceived the idea of applying the old,



Capt. W. H. Richard, world famous rifleman, shooting the heavy barreled sniper's rifle that he invented

heavy barrel principle to a modern high power rifle. He obtained two barrels, one rifled with six, and the other with four, grooves. These he mounted on a Springfield stock. Experiment resulted in modifications, and the present product is an 8-pound barrel 26 inches long tapering from $1\frac{1}{8}$ inches diameter at the chamber to $\frac{7}{8}$ inch at the muzzle. While this type of rifle weighs about 11 pounds, the weight is well distributed.

Floating Cradle Lays Jointed Pipe across River Bed

BY THE ingenious use of a timber cradle 150 feet long, suspended between two moving barges, engineers recently set new speed records in submerging thousands of feet of flexible joint, 30-inch cast iron pipe under three rivers that cross the route of a 20-mile water supply line running into Norfolk, Va.

The timber cradle was hung so that the lower end moved along the river bottom, while the upper end projected above the barges. The pipe sections were joined one after another at the upper end of the cradle, and as the barges moved slowly forward the jointed pipe slipped down the curved skid-way of the cradle to the river bottom.

The total width of the three rivers under which the pipe was submerged in this manner was nearly two miles, and the pipe was lowered to depths ranging from 20 to 85 feet.

Before the pipe was laid, trenches were excavated across the beds of the streams and

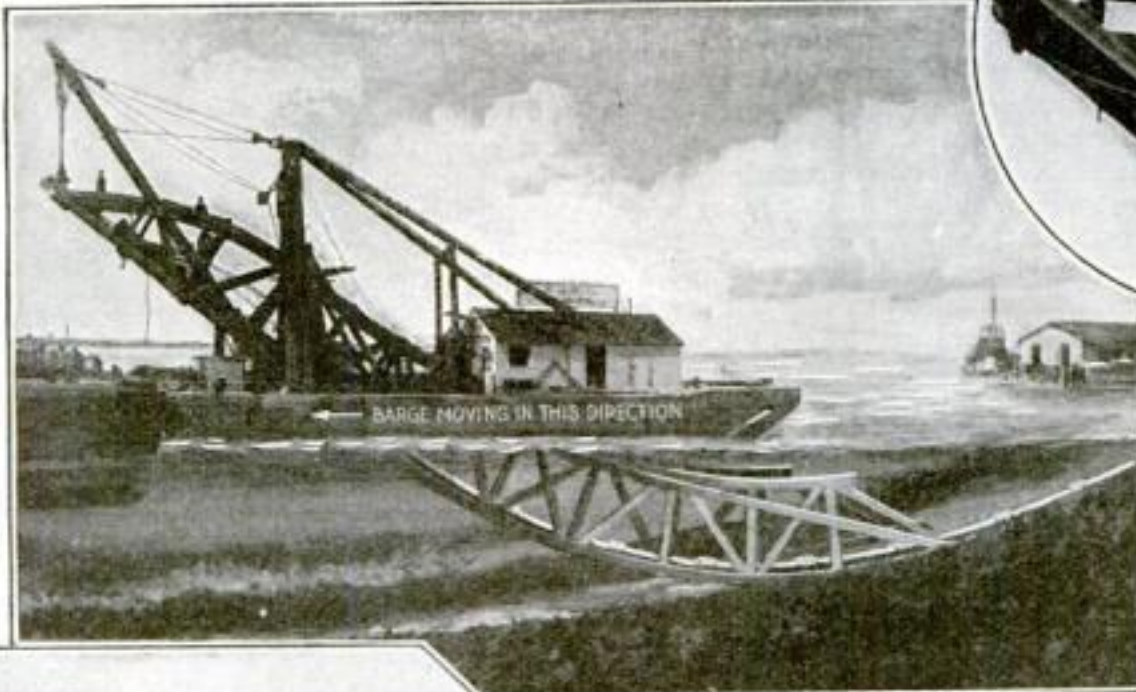
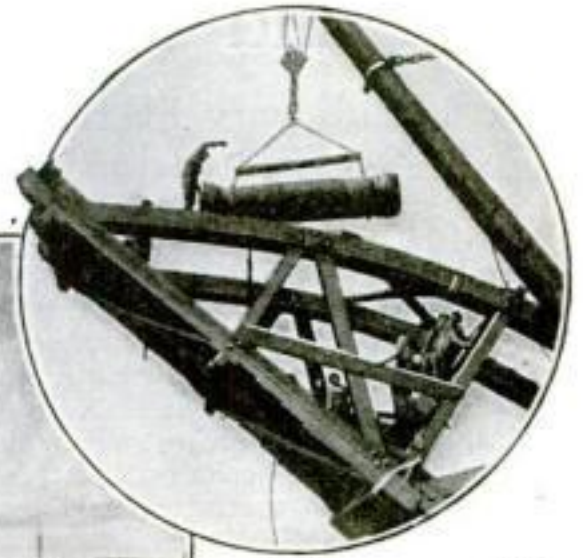
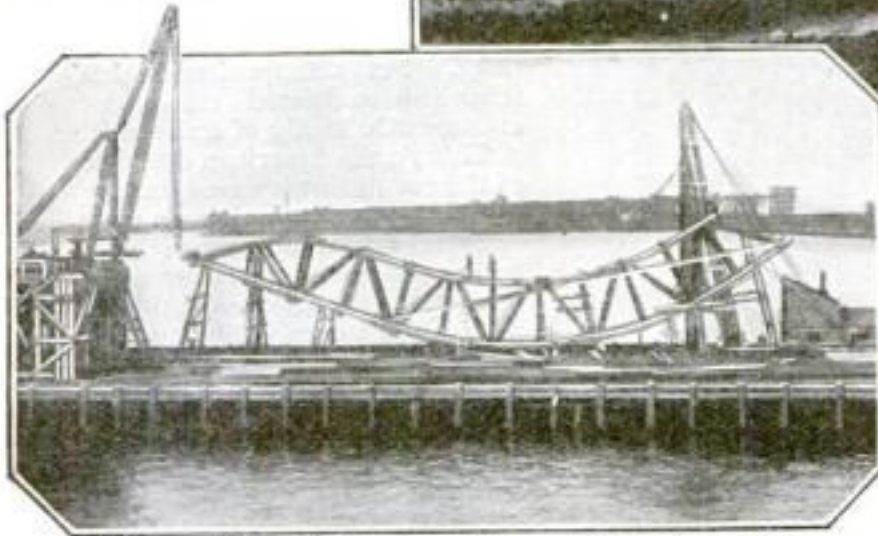


Photo courtesy Engineering News-Record



At the upper end of the cradle (above) pipe sections were laid one by one and joined. Then, as the barges supporting the cradle moved forward, the jointed pipe slid down a curved skid to a trench at the river bottom, as shown at left



The 150-foot timber cradle used in submerging pipe across three Virginia rivers

the irregularities in each trench were eliminated by pulling a rectangular drag, weighing three tons, along the bottom by cables.

The lower end of the pipe laying cradle was kept in contact with the river bottom, whatever the depth of water, by raising or lowering purchase blocks and tackle

by which the cradle was swung from the two barges.

On the derrick barge a special pot was swung from a furnace to the cradle and from this pot each joint was poured. As soon as the lead was poured and before the bell of the pipe joint had cooled, the joint was carefully caulked and then chilled. After the bell had cooled, the joint was "broken" to allow the pipe to conform to the curve of the cradle. The entire pipe laying rig was then moved forward and the pipe allowed to slip down as the cradle advanced.

Coloring the Wood of Living Trees

FURNITURE manufacturers in Germany have developed an ingenious method of dyeing the wood of living

trees instead of waiting until the tree is cut down and sawed into lumber to apply the coloring.

A solution of the dyestuff in water is supplied to the roots of the tree through a tube from a tank suspended from the trunk at a height of 10 or 15 feet. The dissolved dyestuff, absorbed by the roots, is conducted with the sap, through the long cells of the wood in trunk and branches, to all parts of the tree, including the foliage. The solution passes from cell to cell through the inclosing cell membranes by osmosis—that is, the tendency of fluids to pass through porous partitions and mix—and imparts a uniform color to the wood fiber.

A tree from 60 to 70 feet high requires approximately four weeks to become thoroughly permeated by the dyestuff. Then it dies and is cut down to be sawed and seasoned into lumber suitable for furniture making.

Not every dyestuff can be used in this method, for unless it forms a true solution, it will not pass through the membranes of the wood cells. A similar method has been suggested for impregnating the wood of living trees with preservatives that would prevent their mature decay. This method means a considerable saving in labor and expense over former processes.



From a tank suspended on the tree trunk, the dye solution is carried through a tube to the roots



Trap Harpoons Animals

BASED on the principle of the harpoon, a new spring gun for trapping furbearing animals, has been designed by Mr. V. M. Brown, of Medicine Lodge, Kans.

The trap includes a barrel in which is mounted a spear that is driven downward by a coiled spring concealed within the barrel. This spear is normally concealed and held by a trigger to which is attached a long rod terminating in a bait hook.

When the animal pulls on the bait, the spear is automatically released and driven into the animal by the force of the spring.

New Stagecraft Lifts Scenes through Floor and Paints Them with Light

Revolutionary Playhouse-Amphitheater without Aisles
Created by Young American Designer

IMAGINE yourself entering a square theater without aisles, and in which the stage, instead of being "framed" like a picture, at one side of the auditorium, juts out from a corner, presenting a wide circular front to the audience. No stage curtains, back drop, or orchestra pit are in sight—just a bare, colorless platform, separated from the spectators only by a low flight of steps.

Arranged in quarter circles concentric with the curve of the stage front, widely separated rows of seats form an aisleless amphitheater. Above, a domed ceiling extends over both the audience and the stage site. There are no balconies.

You reach your seat by passing along the wide space that separates your row from the row in front. And as you do so, from somewhere come strains of music from a hidden orchestra, sounding as if the orchestra were directly in front of you.

A Stage Suddenly Appears

The lights go down. Then all at once the stage appears in a blaze of light, the source of which you cannot trace. You are amazed to see before you a complete stage with scenery where, but a few seconds before, only a bare platform was visible. The play begins and—thrilled by the spectacle before you, a flashing, changing, melting riot of color—you seem to have been made a part of it, by some mysterious agency that you can't understand. The act ends, and as the lights go up, you are strangely aware of the bare platform, where the stage, with its gorgeous scenic effects, had been only a moment before.

Such is the revolutionary new theater designed by a brilliant young creator of stage settings, Norman Bel Geddes, of New York City. Use of the marvelous scientific lighting effects, lately perfected, has been limited hitherto by the design of theaters built for old-fashioned stage settings. Mr. Geddes has now designed a theater especially to give full scope to these modern lighting methods.

Until recent years our stage scenes, framed by the confining opening of the proscenium, produced the effect of a two-dimensional picture—that is, the settings lacked full natural perspective. It is to release the actor and playwright from this serious handicap that Geddes and other younger artists of the stage have been devoting their efforts. Theaters of this type have already been planned for construction in Los Angeles and other cities.

The scheme conceived by Geddes is simple

enough. The seats are confined to the main floor and a few boxes or stalls at the rear of the auditorium. The audience is literally seated around the stage, and, strange as it may seem, even though the concentric rows of seats are separated by 4½-foot spaces between chair back and chair back, Geddes' plan actually provides more seats and a deeper stage than does a theater with orchestra, balcony, and gallery. Since the stage is actually projected into



Stage Setting Painted with Light

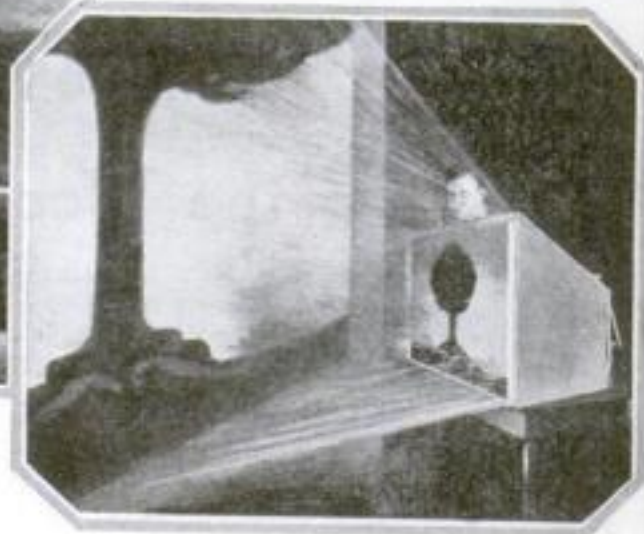
Beautiful stage effects like that from Bernard Shaw's "Back to Methuselah," shown above, are produced, not by painted back drops, but by combinations of light projected from back stage through a colored screen as shown at right



Norman Bel Geddes

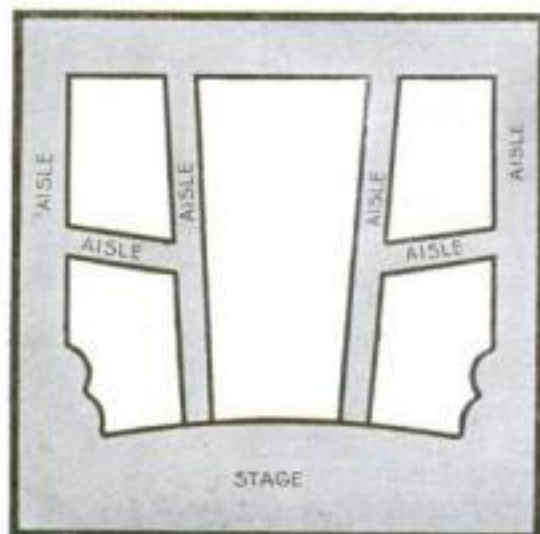
EQUIPPED with six months' training in art school, Norman Bel Geddes, of New York City, is one of the greatest modern designers of stage settings. For this profession his schooling consisted chiefly of enthusiastic study of stagecraft.

This young American designer of the revolutionary new theater made his start by writing a play and designing the settings. Now he is endeavoring to remove the limitations that surround the American stage. Theaters of this general design have been planned for Detroit, Cincinnati, and Los Angeles

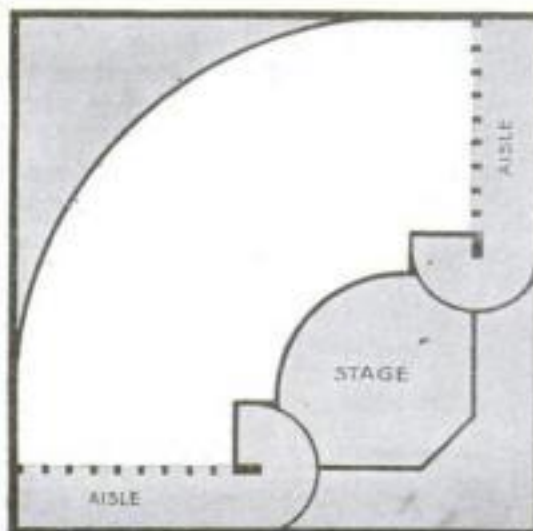


the audience, none of the present cumbersome devices for settings, such as curtains and drop, is required. The stage platform, which supports the scenery, is lowered or raised into place by hydraulic plungers. When, at the close of a scene or act, a change of scenery is required, the entire stage setting is lowered into the basement, and rolled from the platform into an alcove provided for it. Then the new setting is rolled onto the platform, which is raised to the auditorium. The hydraulic plungers will lower or raise a stage in 12 seconds.

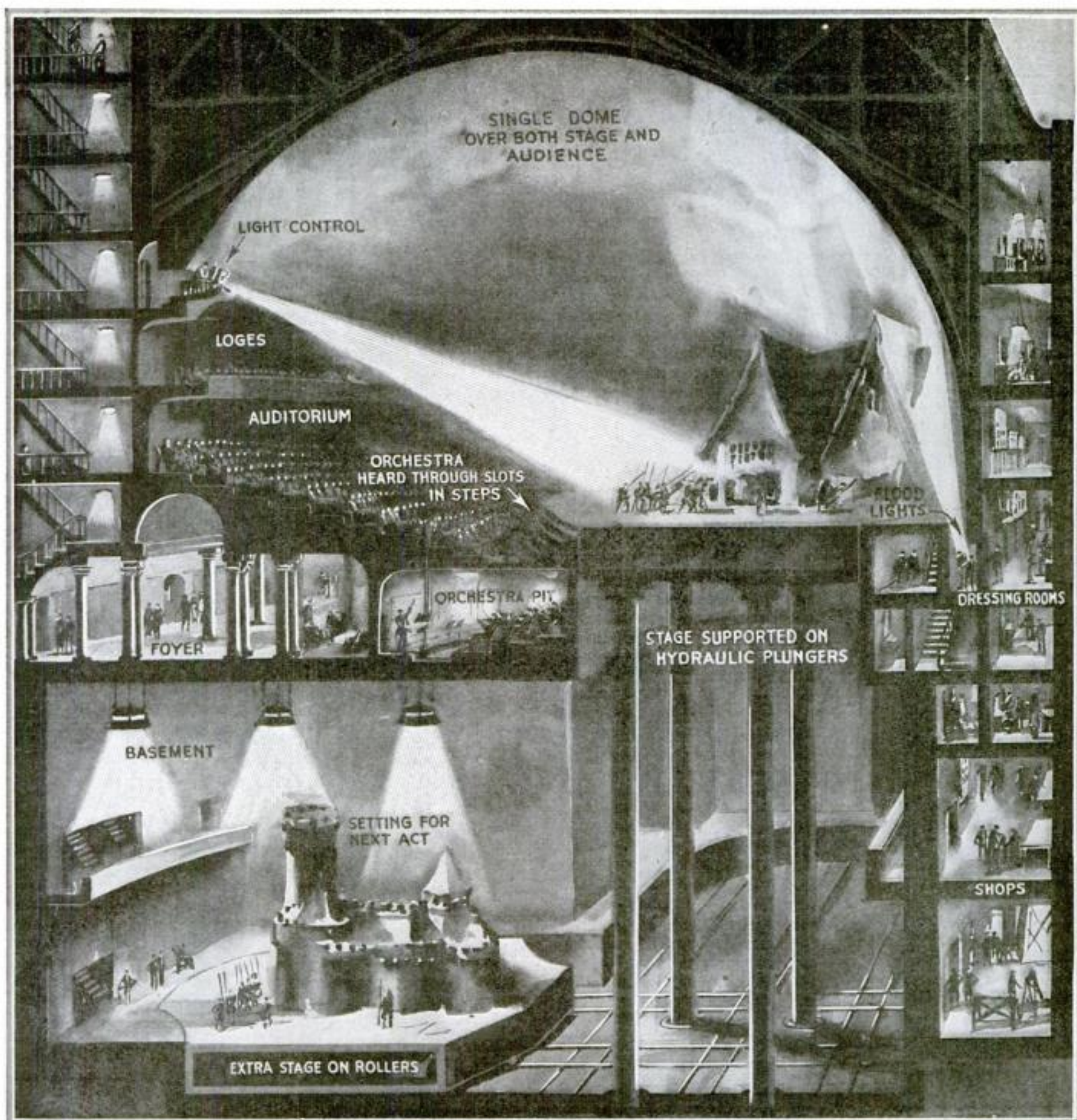
Immediately beneath the inclined floor of the auditorium, on the level of the street, is a floor that is occupied by a large



Arrangement of stage and main floor of a typical theater of today. Note position of stage on one side of the square, and the cross aisles breaking up seating space



The Geddes plan, showing corner stage and aisleless auditorium. Main floor alone seats 872 persons—50 more than main floor and balconies combined in present theater of same size



This remarkable cross section view of the theater designed by Norman Bel Geddes shows the ingenious method by which an entire stage with its settings is lowered on hydraulic plungers at the close of an act or scene, to be replaced by a new setting

that is rolled onto the plungers and lifted to the auditorium for the next act. Scenic effects are "painted" by colored lights projected from the rear of the theater

foyer extending around two sides of the theater. The remaining "underground" space between the foyer and the stage well is occupied by the orchestra, entirely concealed from the audience above. Back of the stage well are dressing rooms.

Finally, underneath this orchestra level is the basement, in which stages are rolled on and off the hydraulic lifts, scenery is kept, and various workrooms are housed.

"Painting by Light"

Especially interesting are the stage itself and its background, which consists either of a plaster dome or canvas cyclorama. Geddes supplies background partly by a quarter circle of canvas set up at the rear of the stage itself, but mostly by "painting by light."

The originators of this art conceived the idea of employing light to "paint" scenery

by throwing colored lights from projection lamps on a plaster dome, or on a semicircular canvas back drop. They developed three systems of "color painting," which were introduced in America by Lee Simonson, another young American stagecraftsman.

The first of these methods—that used by Adolph Linnebach, of the Schauspielhaus in Dresden—consists of a simple lantern containing an arc light, but no lens, which throws onto the plaster or canvas background designs painted on glass. Thus, instead of painting scenes on canvas drops, as is now done, the scenery is actually painted on glass and then projected, like a stereopticon view.

The second method is that used by Max Hasait at the Dresden Opera, and adopted in New York with some success. Hasait projects a design in shadows by means of a frame, across which are fastened various

thicknesses of gauze. The light that filters through one section of the gauze is of greater intensity than that projected through another section, resulting in a well-defined shadow on the plaster dome, or cyclorama. Whatever color is desired is furnished by spotlights.

Source of Light Unseen by Audience

Finally, a method called the "Ars system" includes not only remarkable projection devices for reproducing realistic cloud-effects from drawings or photographs, but also a battery of high powered bulbs and lenses, by which color designs painted on glass slides may be projected, as if from a magic lantern.

In his new theater Geddes provides for "light painting" by locating his light projector in a balcony in the back of the auditorium, out of sight of the audience.

Compressed-Air Tube Passes Red Hot Rivets

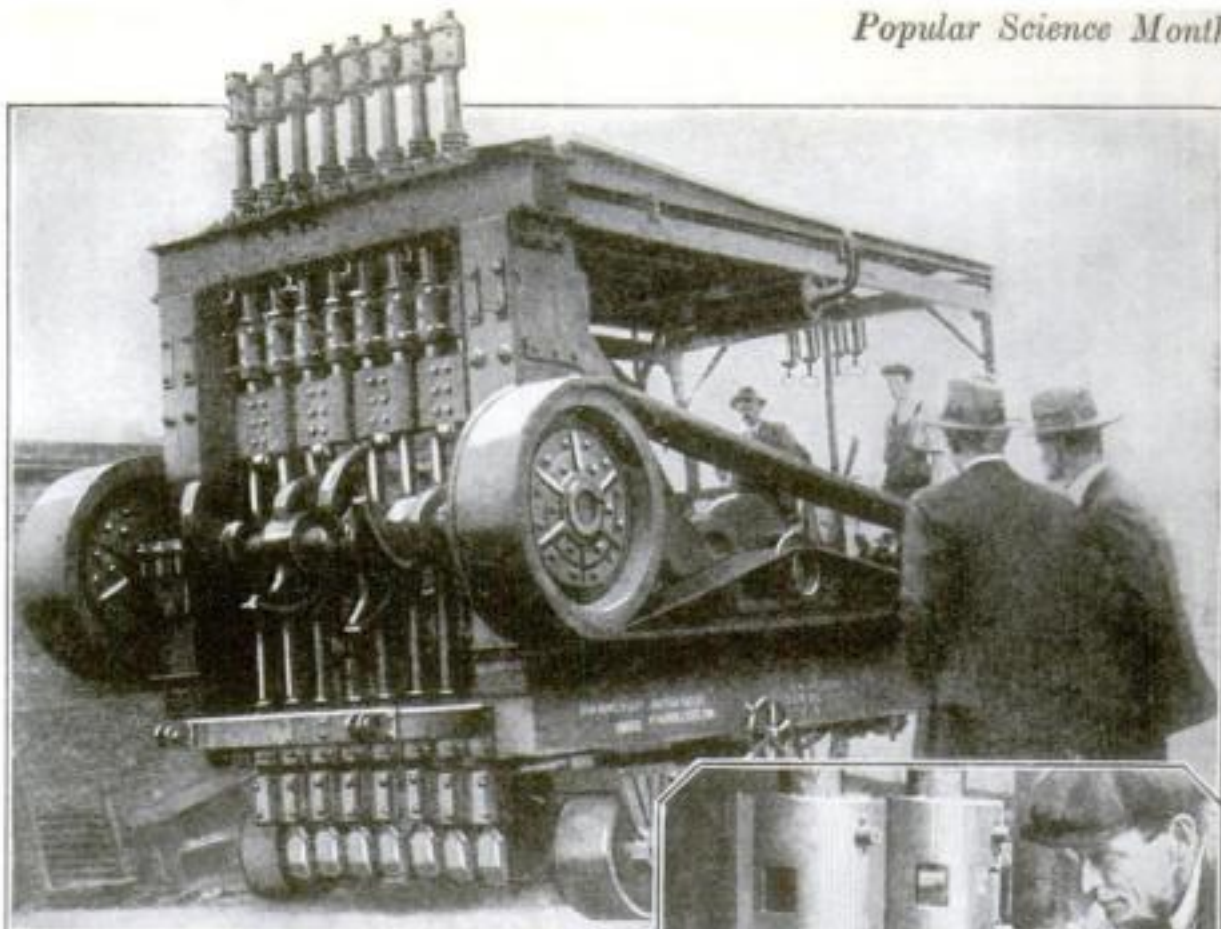
RIVET-PASSING by compressed air through a flexible metallic hose is replacing the dangerous bucket-and-tongs method. The new apparatus consists of a simple compressed-air gun and storage tank and a metal hose that leads from the forge to the riveter.

By its own weight the red hot rivet, dropped by the forgerman into a receptacle at the end of the hose, opens a valve that closes again automatically. The forgerman applies the compressed air by pressure on a foot pedal, and the rivet shoots down the hose to the job, arriving free from scale, and without possibility of accident. Rivets can be delivered 125 feet at the rate of 50 feet in three seconds by only $3\frac{1}{2}$ pounds of air.

A 20 per cent saving in cost of operation, as well as greater safety, are advantages claimed for the new compressed-air method.



Dropped into the compressed-air tube, the hot rivet opens the valve



In crushing a cement road, a battery of heavy plungers, with removable chisel-shaped points, shown at right, are raised and lowered by eccentric levers on a shaft driven by the truck motor

Plunging Chisels Crush Concrete Road

THE work of battering and stripping the body of a hard concrete road—always the most difficult part of a road repairing job—has been greatly simplified by the invention of a powerful road-breaking machine mounted on a truck driven by a gasoline engine, and similar in design to the crushers once used in stamping mills to crush quartz and metal ores.

Eight heavy steel plungers, connected in couples and provided with removable wedge shaped chisel points at their lower ends, comprise the battery of crushers placed in a row at the front end of the truck. These plungers slide in bearings and are alternately lifted and dropped by four



eccentric levers keyed to a rotating shaft driven by the truck engine. The weight of the plungers is so great that, as they drop from a height of about two feet, their sharp chisel points cut through the concrete and break it into fragments.

Two heavy flywheels provide for continuity of the reciprocating motion of the plungers. The machine weighs about two tons.

Whenever one of the chisel points becomes worn or broken, it is quickly replaced by another.

Four Thousand Miles in a Rowboat

IN A 16-foot combination power and row boat driven by a single cylinder, $2\frac{1}{2}$ -horsepower engine, Walter P. Horger and Henry J. Miller started from Detroit, Mich., recently on a 4000-mile cruise through the Great Lakes as far as Duluth, Minn., and back.

Their route was through the center of Lake St. Clair, along the American shore of Lake Huron, across the middle of Saginaw Bay, through the straits of Mackinaw and St. Mary's River to Lake Superior, and finally along the Wisconsin and Minnesota shores to Duluth.

Under ordinary weather conditions and in smooth water the boat is capable of making from seven to eight miles an hour. It is equipped with a canvas top with two holes through which the adventurers can stick their heads. This top keeps out water during heavy seas.



The map above shows the 4000-mile route of Horger and Miller in their cruise through the Great Lakes from Detroit to Duluth and back in a 16-foot power and row boat



House Numbers on Curbs

PAINTING house numbers on the curb where they are in plain sight of automobilists and drivers of delivery cars, is a practice that is becoming popular with residents of Glendale, Calif.

The numbers are stenciled on the curb with lampblack and oil and will last for years. Before the stenciling, the curb is cleaned with a stiff steel brush. The numbers used are about six inches high. The cost of stenciling the complete number is only 25 cents, yet the saving of time to merchants in making deliveries is said to amount to thousands of dollars a year.

Six-Story Foundation for Apartment House to Hold Garage

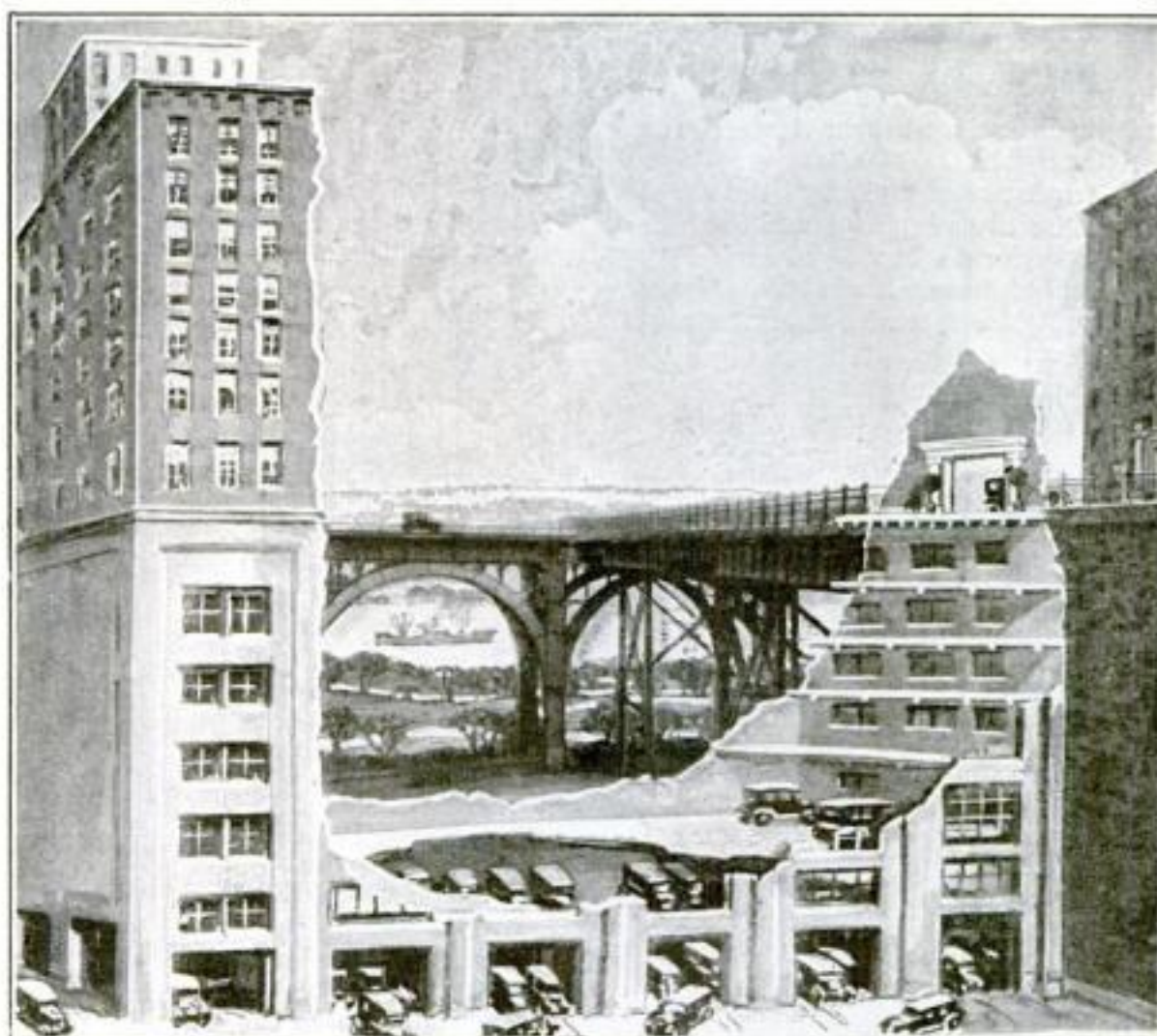
APARTMENT houses with entrances at the sixth floor, 80 feet above the ground, will soon be constructed in the fashionable Riverside Drive district of New York City to face an elevated cross street that bridges a deep valley and joins the elevated drive at 134th Street.

Since residences on Riverside Drive and on cross streets leading from it command high rents, builders quickly seized the opportunity offered by the opening of the elevated street. They found it impracticable, however, to build residences from the ground to the 80-foot level of the street. On the other hand, the cost of building a foundation 80 feet high would be tremendous.

How the Problem Was Solved

They are solving the problem by designing an extraordinary type of apartment building in which the lower half, from the ground level to the sixth floor entrance, will inclose garages and warehouses. Upon this foundation building will be erected the eight-story modern apartment house proper.

All the buildings facing Riverside Drive and the cross street to a distance of 200 feet from the intersection of the elevated streets will be of this type.



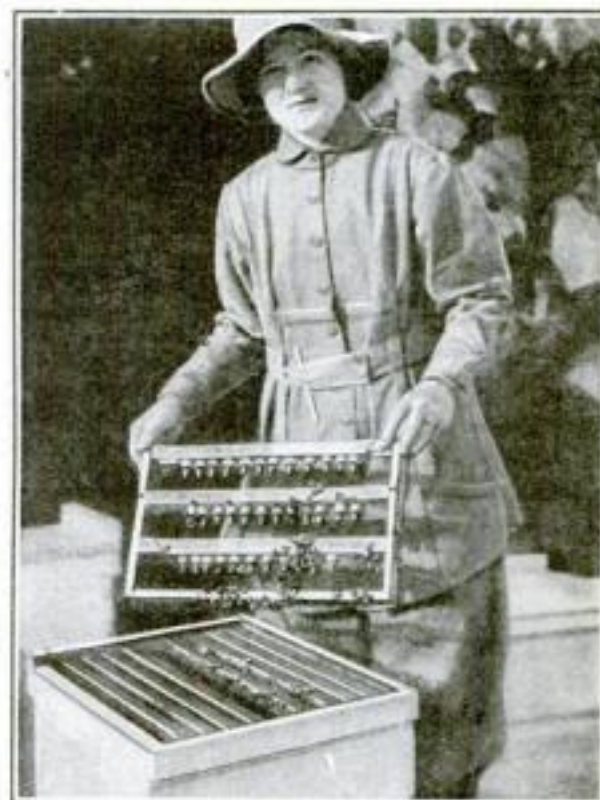
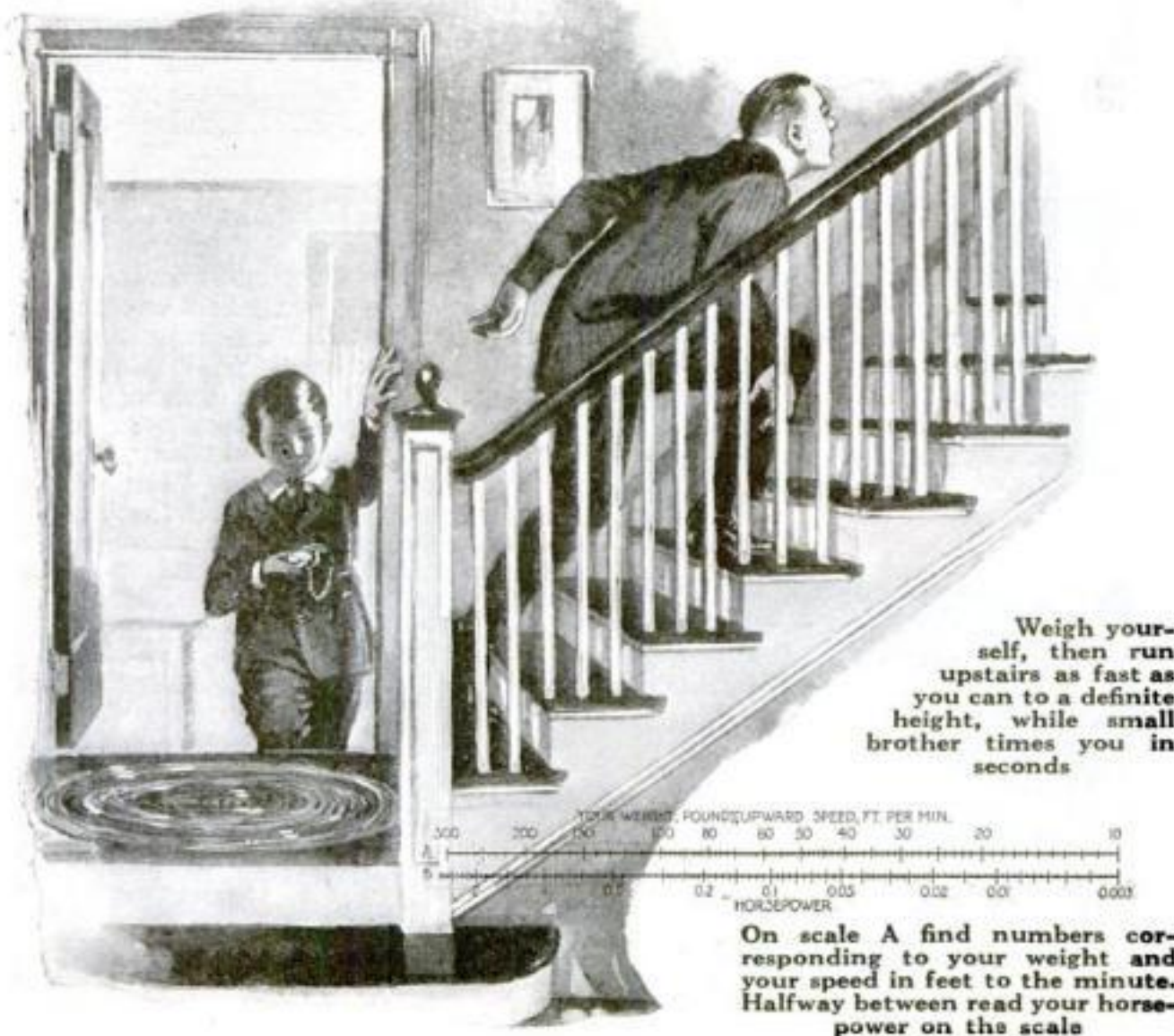
Cutaway view of proposed apartment house showing garages in foundation

How to Measure Your Body's Horsepower

DO YOU know how strong you are? Run up the stairs as fast as you can—two or three at a time if you like—and have some one note the time in seconds you require to climb a definite height in feet. From these figures, and your weight, including clothes, you can determine your "horsepower" by means of the chart shown below the accompanying illustration.

Suppose you weigh 150 pounds and climb the stairs at 60 vertical feet a minute. On the upper scale, A, find 150 and 60, and take the point halfway between, or 105. On scale B is your horsepower—about 0.273.

By hauling up a weight with a rope passing over a pulley, you can find the horsepower of your arms, using the table.



Successful Woman Beekeeper Invents Queen Incubator

FINDING millinery less profitable and less interesting than beekeeping, Miss Josephine Whipple, of Los Angeles, Calif., turned professional apiculturist and has recently invented a queen bee capsule, or incubator, in which the queen bee spends the first ten days of her life. It is declared to be a valuable contribution to apiculture.

On the queen bee depends the entire life of the bee colony. She lays the eggs, in cells provided by the workers, and these eggs later hatch into other queens. Queen rearing has become a distinct industry in the United States, with a large export trade.

Miss Whipple's earnings in one year are said to be as high as \$12,000. The profits from the industry may be realized from a recent transaction in which half interest in a prize queen was sold for \$150.

How Plants Bend and Struggle to Reach Light

FIVE minutes of candlelight, streaming through a pinhole, is enough to make the slender stems of little mustard seedlings lean over toward the source of the light!

To get a glimpse of sunshine, the shoot of a tulip bulb will struggle upward through the dark earth for a distance of 11 inches, and at the end of the climb will have enough reserve energy to spread its leaves and create a flower!

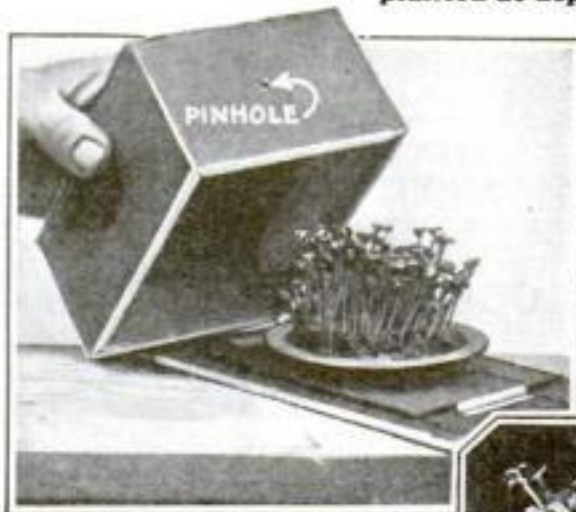
Light, Not Heat, Causes Growth

Interesting facts about the sensitiveness of plants to light and the energy they put forth under its influence have been revealed in a series of experiments, conducted by scientists of the United States Department of Agriculture during the past year, that have revolutionized our knowledge concerning the effect of light on plant growth. The work of Uncle Sam's experimenters in discovering a brand new agriculture in which the growth of plants is governed by light rather than by heat was described fully by Lewis E. Theiss in an article in the December issue of *POPULAR SCIENCE MONTHLY*.

The new experiments with tulip bulbs, incidentally demonstrating the tremendous growing power of the bulb in response to light, are illustrated at the top of this page. When a bulb was covered with six inches of soil, its shoot easily reached the surface and developed healthy foliage and flower. When the soil covering was increased to 11 inches, the bulb had sufficient energy to send its shoot to the surface, expand



These remarkable photographs show the tremendous growing power of tulip bulbs seeking the light, and the growth of their plants when the bulbs were planted at depths of six inches, 11 inches, 12½ inches, and 14 inches (left to right)



The experiment that revealed the extreme sensitiveness of mustard seedlings to light. Covered by a box into which candlelight was allowed to filter through a pinhole, the seedlings after five minutes were found to be leaning toward the source of light, as shown at the right

leaves, and create a fairly perfect flower, although the portion of plant above the ground level was comparatively small.

And even when the covering was increased to 12½ inches, the plant from the bulb

managed to struggle to the surface, even though its flower was unable to make the grade, and remained within 1½ inches of the top until it shriveled.

Plant Makes a Brave Fight

Covered under 14 inches of earth, the bulb shot up its plant 13 inches and then abandoned the struggle.

In the experiment revealing the sensitiveness of mustard seedlings to light, the seedlings were covered by a box with a pinhole in the center of one side. After this hole had been uncovered for five minutes to admit the light of an ordinary candle, the little plants were found leaning over in the direction from which the light came.

Further interesting experiments were made by Dr. R. B. Harvey, of the University of Minnesota. By illumination from tungsten filament nitrogen-filled lamps he ripened many varieties of seeds in unheated basement rooms, where no sunlight entered.

Wing Spars Support Engine of New Loening Monoplane Racer

DEPARTING from the usual "automobile type" of airplane construction—that of supporting the engine, with propeller, on the longerons or longitudinal members of the fuselage, Grover C. Loening, famous young American airplane inventor and designer, has perfected an extraordinary type of racing monoplane in which the wings and the powerful engine they support form a complete flying unit in themselves.

Loening has added just enough length of feather-weight fuselage to provide for the pilot's cockpit and the tail surfaces.

The new machine, said to be the most powerful for its size in the world and able to attain a speed of 200 miles an hour, was entered in the recent Pulitzer Trophy race at Detroit, Mich. One of its chief advantages is said to be

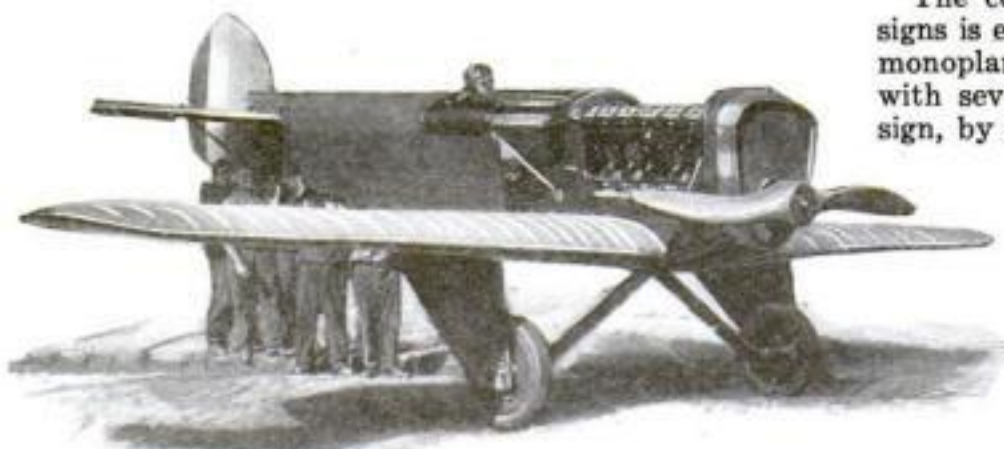
reduction in weight and wind resistance. It weighs 2700 pounds ready for flight.

The extraordinary feature of construction is the fact that the engine is mounted directly on top of the monoplane wing, the weight of the engine being supported by heavy transverse spars running the full

length of the main wing structure. This makes possible extremely light construction of the fuselage, which is only twice as long as the engine and is built just heavy enough to support the pilot and tail surfaces.

The 600-horsepower, 12-cylinder engine can develop 630 revolutions a minute.

The continued success of Loening's designs is evidenced by the fact that his fast monoplane air yachts have been adopted, with several minor improvements in design, by the Army Air Service.



The powerful new Loening racing monoplane, showing how the engine is supported by the heavy braced monoplane wings. Note the comparatively short length of the light fuselage

Tanks Waste Fuel

A TON of coal a year is wasted by each uninsulated hot-water tank in use in American homes, according to the statement of a prominent manufacturer. Four fifths of this loss is preventable, and greater economy is possible if all hot water and hot air pipes are insulated.

Automatic Speed Control Brakes Train at Curves

DESIGNED to prevent disastrous train wrecks due to the failure of engineers to observe block signals or their carelessness in taking curves at excessive speed, an automatic train governor, designed by E. Rodolause, a French engineer, not only makes a train foolproof, but actually keeps an accurate record of a train's performance by which the engineer's competency can be judged.

Control Keeps Tab on Train

Here are a few of the things that the governor does automatically:

Stops a train the instant the locomotive passes a block signal.

Brakes a train when its speed in taking a curve passes a certain specified limit.

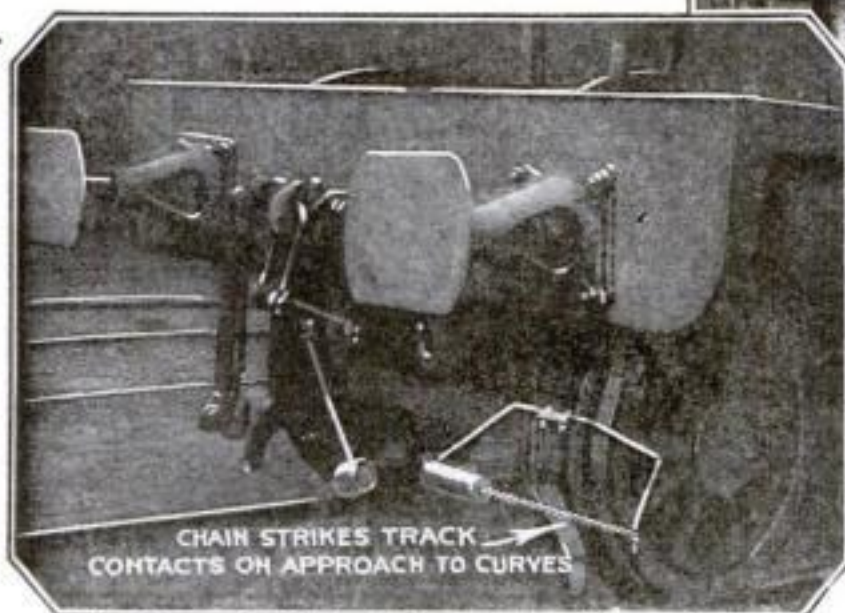
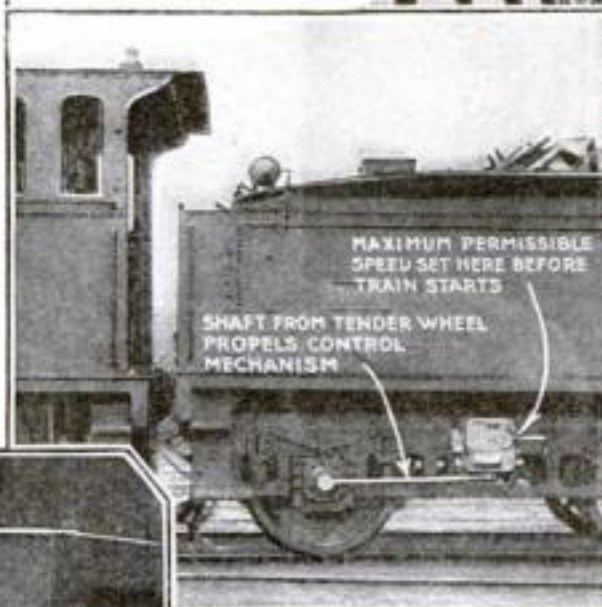
Makes a permanent speed and braking record, showing every action of the train on an entire trip.

The automatic control mechanism, contained in a small box attached to the locomotive tender, is propelled by a shaft from the foremost tender wheel, and is set to a specified maximum speed by means of a dial on the outside of the box. When the speed of the train, transmitted to the control mechanism through the shaft, passes

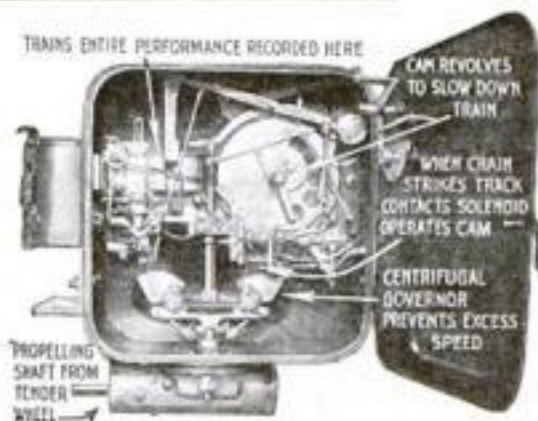
Caused by the failure of an engineer to heed a block signal, this disastrous rear-end collision near Sulphur Springs, Mo., in which 35 persons were killed and more than 100 injured, might have been prevented by the automatic control shown below



This Train Passed a Block Signal



The impact of this chain fender with track contacts on approaches to curves sets the brakes



Inside control box, showing speed and brake adjustments

the specified maximum, a centrifugal governor automatically opens a safety valve that applies the brakes until the speed of the train falls below the maximum limit.

At the front end of the locomotive is a chain fender adjusted to strike vertical rods placed along the railway line at approaches to dangerous curves, or wherever tracks or switches are not clear. The impact of one of these rods on the chain, as the locomotive passes, is transmitted to a solenoid in the control box. This solenoid operates a cam wheel that opens a safety valve and sets the brakes.

Meanwhile, every operation of speed regulating and braking is recorded on a paper strip.

This Raft-Boat Sails against the Wind by Wind Power!

DRIVEN by the power of the wind, yet able to progress against the wind at moderate speed, a small water craft of unique design recently made several successful trial trips on the Seine River, near Paris, navigated by the inventors.

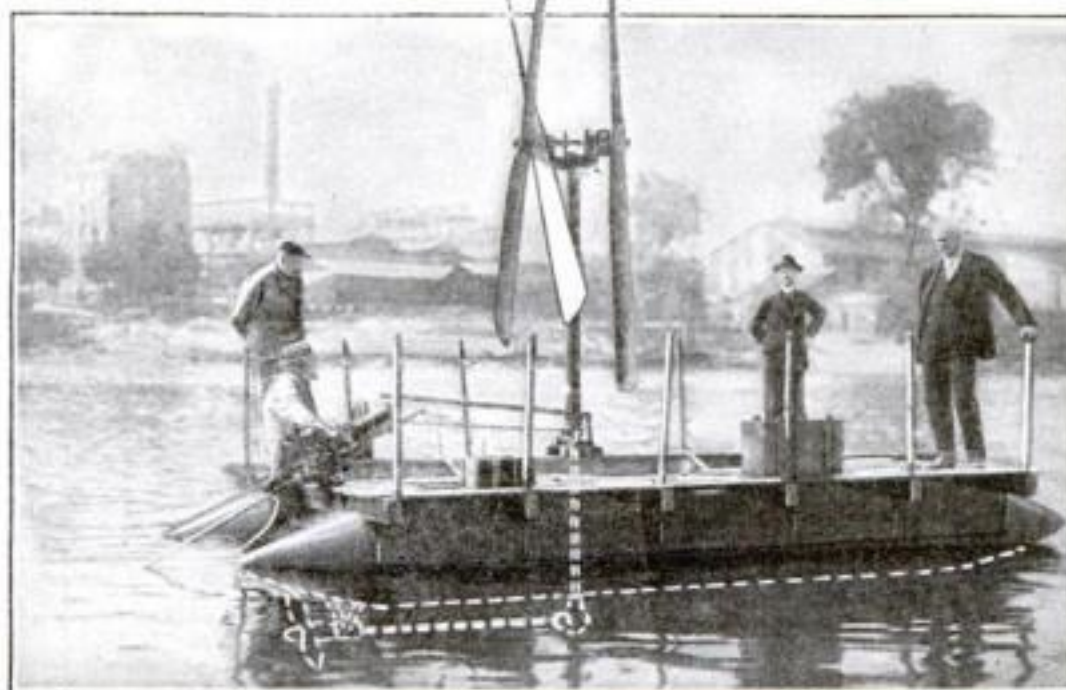
The apparent paradox of sailing against the wind by wind power is explained as follows:

Saving Energy

The wind turns large vanes like those of a windmill and the energy thus generated is transmitted by a belt and pulley to a shaft, the submerged end of which carries a propeller. As the blades of the submerged propeller press against a much heavier and more substantial medium than the air propeller, the slippage is much smaller. The saving of

energy resulting from lesser slippage and greater speed of revolution makes it possible for the craft to move contrary to the direction of currents that supply the power.

The inventors have built several models on a small scale, the largest of which is a raftlike craft of three tons, about 18 feet long. The success of the trials has encouraged the inventors to undertake the construction of a five-ton craft of the same type.



Wind propelled craft, showing how vanes drive submerged propeller

Home Humidifiers

THE necessity for increasing the humidity of the air we breathe in our heated homes, if we would prevent wintertime sickness, was pointed out in the December POPULAR SCIENCE MONTHLY.

Growing recognition of this has induced builders of some of the finest homes in America to equip them with air humidifying apparatus. A manufacturer specializing in such devices reports recent installations in new homes in many cities.

Where the Bottom Fell Out of the Sky

Eye-Witness Describes Colossal Cloudburst in a Western Canyon

By John Edwin Hogg

I HAVE just talked with the only eye-witness of the most colossal cloudburst recorded in modern times—with Joe Lacy, a guardian of the Los Angeles water supply aqueduct, whose family fled up the hills from their doomed cabin on the edge of the Mojave Desert, Calif., while a wall of water 60 feet high thundered down the canyon at their heels.

This phenomenal deluge occurred a few months ago, over a region of four square miles, within the watershed of Sand Canyon, a gorge descending from the Sierra Nevada Mountains in southern California.

A Twelve-Foot Sheet of Water

Within the space of half an hour it is estimated that 240 inches of rain fell on this small area. Imagine this in a region where two inches of rain in 24 hours is considered a record! Imagine what such a cloudburst would have meant if it had burst over a big city, sending a sheet of water 12 feet thick crashing down upon the homes and streets, wrecking buildings and perhaps drowning thousands.

Even in this mountainous desert region where, through a queer freak of weather conditions, it actually did occur, the cloudburst wrought appalling devastation. It smashed to pieces the only substantial dwelling in the region, carrying a 640-acre pasture bodily down to the desert, and leaving only a great, mud-filled gorge where the homestead had been. Its waters swept more than 30 feet deep over the Los Angeles aqueduct, which crosses the canyon's mouth. They uprooted huge trees that had been growing for 250 years, and left them nothing but battered logs buried in silt, miles out on the desert floor.

An incalculable quantity of earth was picked up in the flood's nine-mile rush down the canyon, and deposited for miles out in the desert, from two to 20 feet thick, in a tremendous, fan-shaped mass, with a front 15 miles wide.

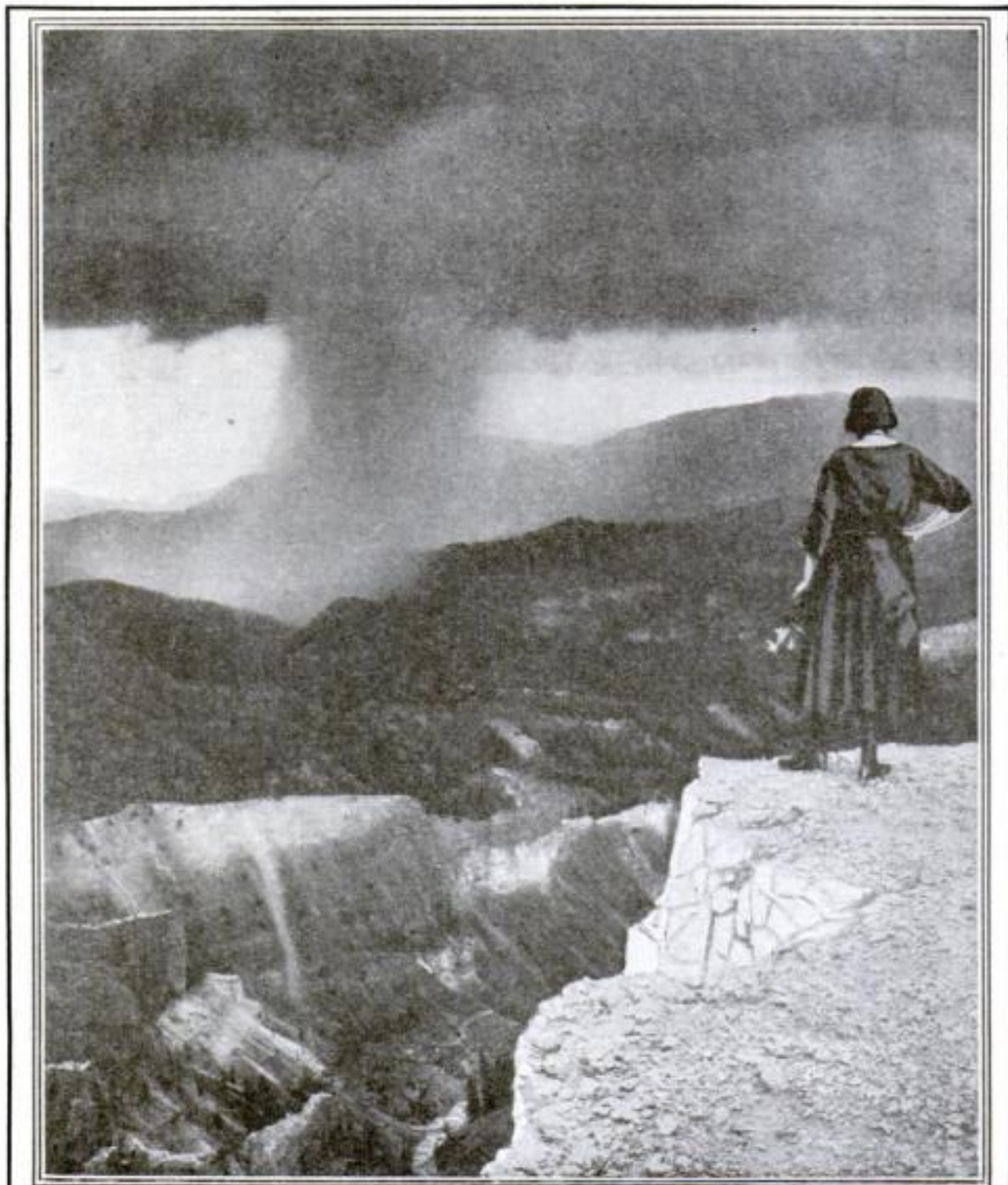
The mud deluge buried the motor road, blocked traffic for several days in the valley, and wiped out some 10 miles of the Southern Pacific's tracks.

Lacy's story of the downpour is dramatic.

Story of Eye-Witness

"It was about nine o'clock in the evening," he told me, "when I heard violent crashes of thunder in the mountains. Then came a roaring, rumbling, crashing noise that sounded like an army of motor trucks coming down the canyon. It dawned on me that the noise was caused by a mighty wall of water rushing down from the mountains above—a deluge that I could see at intervals as the lightning flashed. I could see trees and boulders being flung high as if by huge explosions of dynamite, and come thundering down the gorge."

Lacy had observed the storm gathering over the mountains all day. Early in the afternoon, he saw two thunderstorms gathering.



© Ewing Galloway

This extraordinary photograph of a mountain cloudburst, taken at the rim of the great Colorado River canyon in

southern Utah, shows in the distance a dark deluge emptied by storm clouds in their passage over the mountains



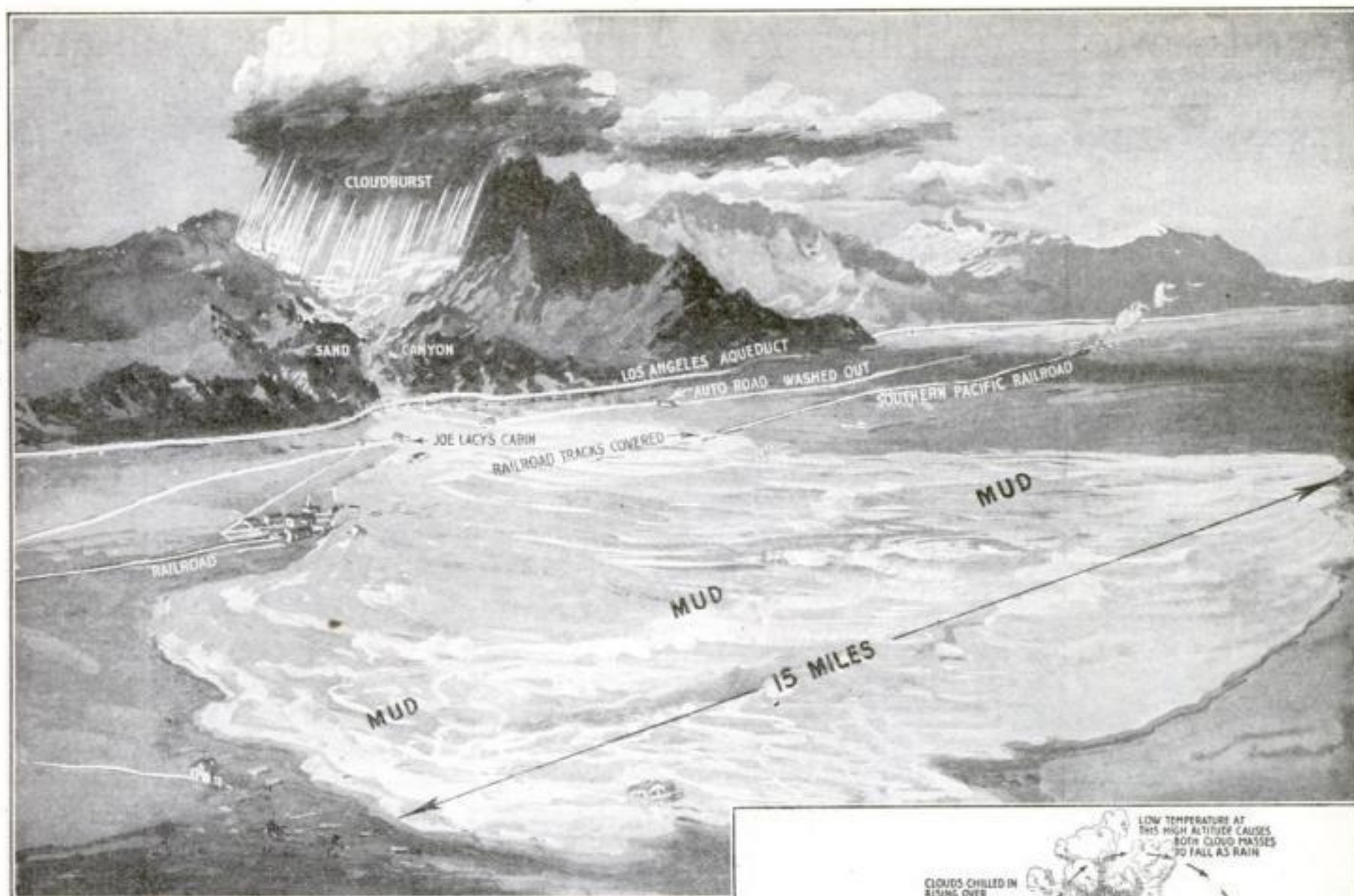
On the floor of the Mojave Desert, 12 miles from the mouth of Sand Canyon, was found this battered tree trunk—the remains of a lofty pine torn from the canyon walls and carried 23 miles

Over the highest hills, near the head of Sand Canyon, were great banks of clouds that appeared to be rushing toward the mountains—and this struck him as extremely unusual, since most of the desert storms come from the mountains to the west.

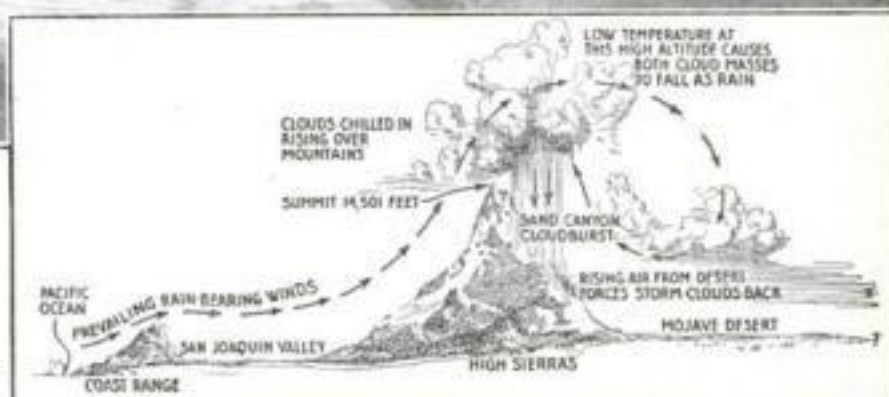
Safety in the Hills

"After I realized what was happening," he continued, "I rushed into the house, shouted to my wife and children to run for the hills, and grabbed a telephone—a private line connecting me with the Los Angeles Water Department. I shouted to the engineer at the other end: 'Sand Canyon is about to be washed off the face of the earth! Send your engineers and workmen, for the city soon will be cut off from water!'"

"Then the line broke, and I rushed to the safety my family had found in the mountains above. From there I watched by lightning flashes the water sweep everything before it, including our home."



THIS bird's-eye view shows the vast sea of mud picked up in the flood's nine-mile rush down the canyon and deposited on the Mojave Desert in a fan-shaped mass 20 feet thick in spots and 15 miles wide. At the mouth of the canyon are shown the Los Angeles water supply aqueduct that withstood the deluge, and the cabin from which Joe Lacy, aqueduct guard, escaped with his family. The diagrammatic sketch at the right illustrates the scientific explanation of the cloudburst.



"My first concern, of course, was for the pipe siphon of the aqueduct that crossed the head of the canyon, for I knew that if it were destroyed, Los Angeles would be cut off from its water supply. Going down the mountainside, as soon as I was certain that the water was not creeping any higher, I found that the top of the huge pipe, 26 feet above the floor of the canyon, was covered with water to a depth of more than seven feet!

"Although battered, the aqueduct was safe. At midnight the water was going out of the canyon at the rate of 2500 cubic feet a second."

From the marks of the flood it is evident that the water in some places attained a height of 65 or 70 feet, while it splattered mud a full 100 feet above the canyon floor.

The reasons for the freak storm were:

Over the west slope of the Sierras, the prevailing rain-bearing winds blow from the Pacific Ocean. To get over these lofty peaks, the clouds are driven to a very high elevation, where they are chilled by the atmosphere, causing the moisture in them to be precipitated in the form of rain.

On this day, there evidently was an unusual meteorological condition that caused a swirl or whirlpool of air currents over the top of Sand Canyon. This wind eddy lasted

all day, gathering clouds from the entire mountain range, and shaping them into a cloud vortex over the canyon. A thunderstorm that had previously passed over the mountains into the Mojave Desert was sucked back into the mass, and a second

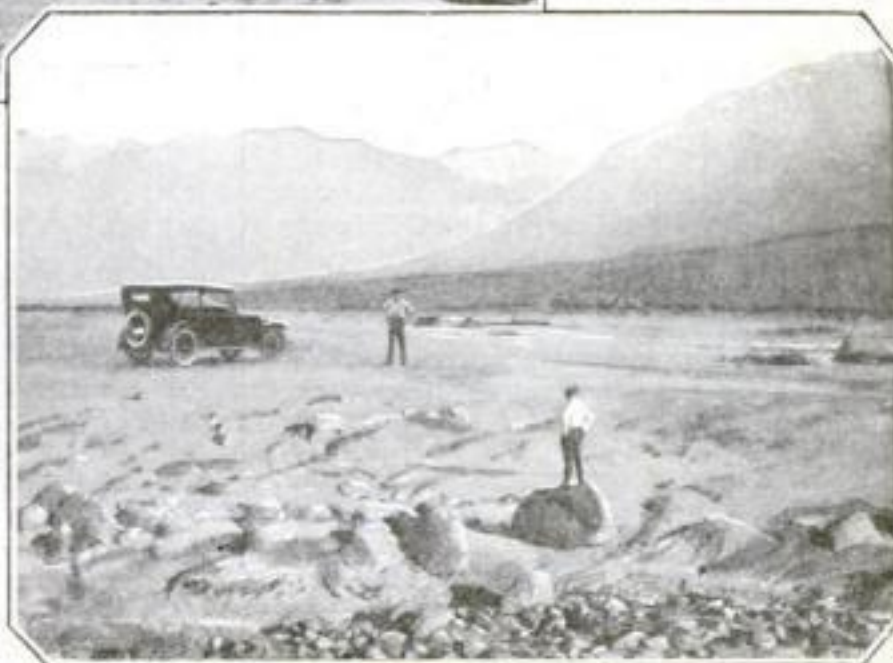
storm met the first one in the small whirlpool of air; the clouds were pushed upward to a tremendous elevation and became instantly chilled, changed into moisture, and poured down in the form of rain. Unquestionably, both storms were of unusual

size. Either one of them in itself would have caused an extraordinary cloudburst. Combined, they dumped more water in 30 minutes onto this small region than would be contained in the entire normal rainfall for eight years.



The enormity of the flood that swept over the Los Angeles aqueduct at the mouth of Sand Canyon is shown in the photo-diagram above. The man on top of the great pipe has raised his arm to indicate the height reached by the waters.

At right: The Mojave Desert with the mouth of Sand Canyon in distance, showing portion of the deep deposit of mud and boulders carried down from the mountains by cloudburst.



First "Mother Ship" for Airplanes to Use Helium

By James M. Scott

UNCLE SAM will soon own the first "mother ship of the air." Carrying beneath her huge 300-foot body a brood of speedy bombing and scouting planes that she can release or pick up while traveling at full speed, the "R-1"—first semi-rigid airship to be built in America—will provide, when completed, an ef-



Herman T. Kraft

Chief aero engineer of the Goodyear Tire and Rubber Company, in charge of constructing the "R-1." He predicts that "the entire surface of the airship of the future will be of metal. And the first practical all metal airship will open wide the gates to the use of the airship commercially"

fective means of patrolling the Atlantic or Pacific seaboard.

Construction of this remarkable "mother airship" for the United States War Department will begin at an early date at the plant of the Goodyear Tire and Rubber Company at Akron, Ohio. And the most significant feature about her—especially from the standpoint of commercial development—is that she will be the first airship to be designed and built especially for the use of non-inflammable, helium gas.

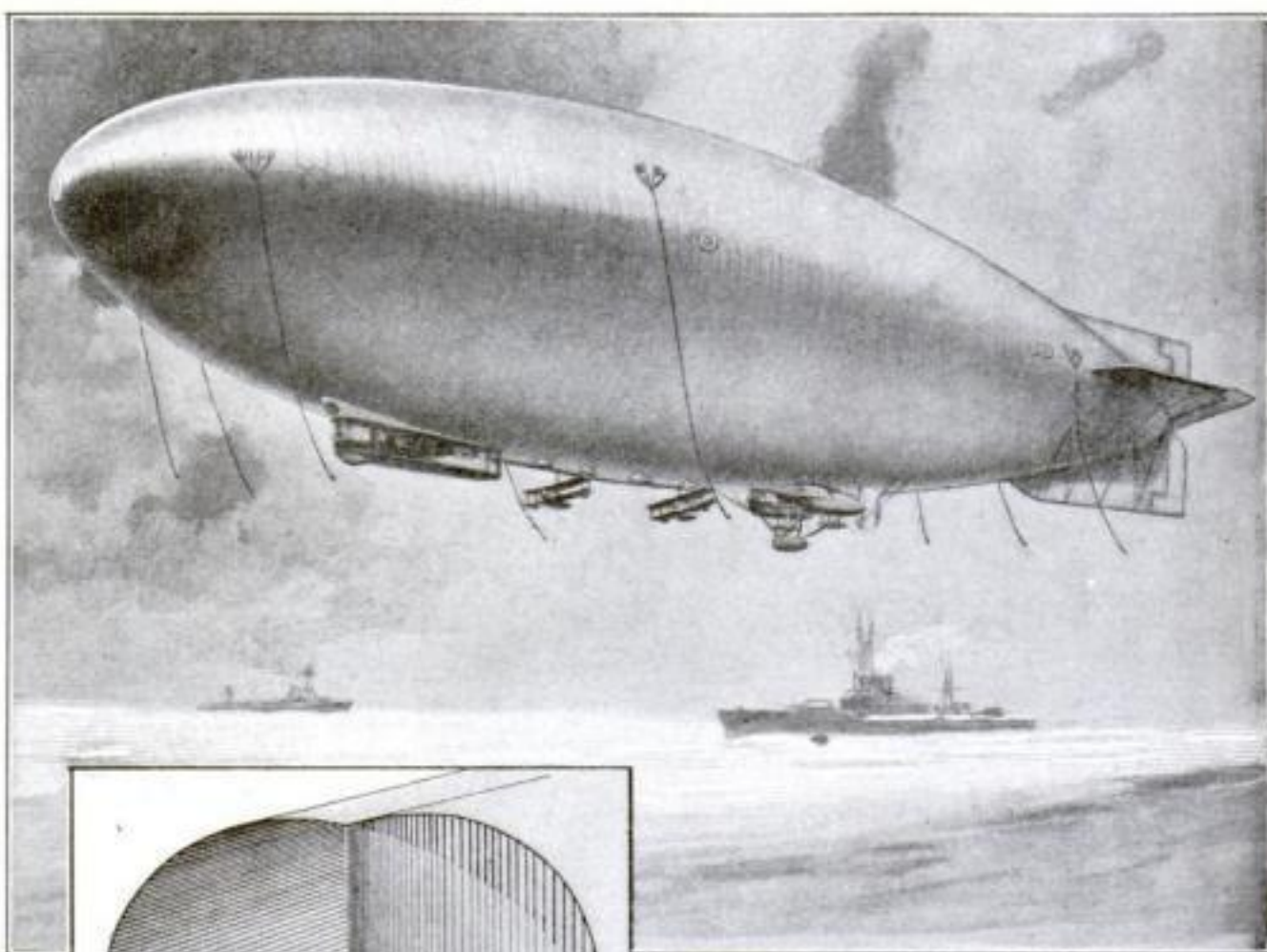
Indeed, Dr. R. B. Moore, chief chemist of the United States Bureau of Mines, in charge of the government research work in connection with helium, declares that the future of lighter than air craft never has been brighter than it is today, and that the problems of helium production have been solved. Within the next decade, he adds, 99.9 per cent helium will be produced at a cost as low as \$20 the cubic foot.

A Rigid, Triangular Backbone

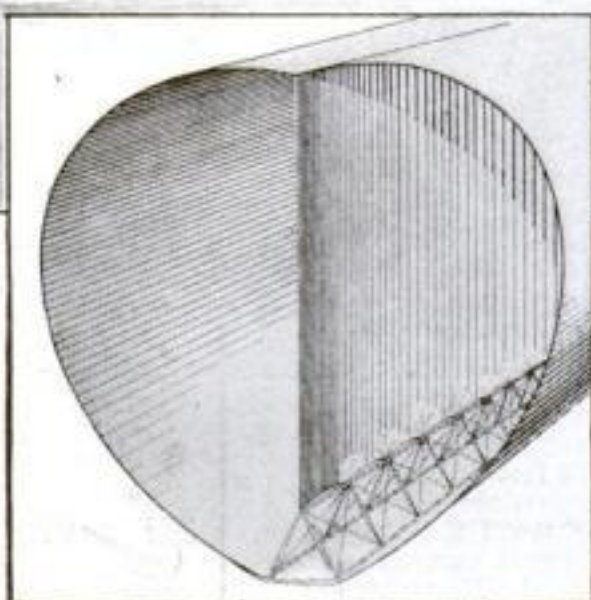
The work of constructing her will be under the direction of Herman T. Kraft, chief aeronautical engineer of the Goodyear Company.

The ship's structural rigidity will be along its backbone, which will consist chiefly of a duralumin framework keel of triangular cross section running from nose to tail. Into this keel will be built the large frame of the nose cone and also the fins, forming one integral structure. It will be driven by four low compression Liberty motors. Three cars, constructed of duralumin and aluminum, will be slung from the keel, the navigation car being forward and the two power cars aft, side by side.

The pilot's car will ordinarily carry a

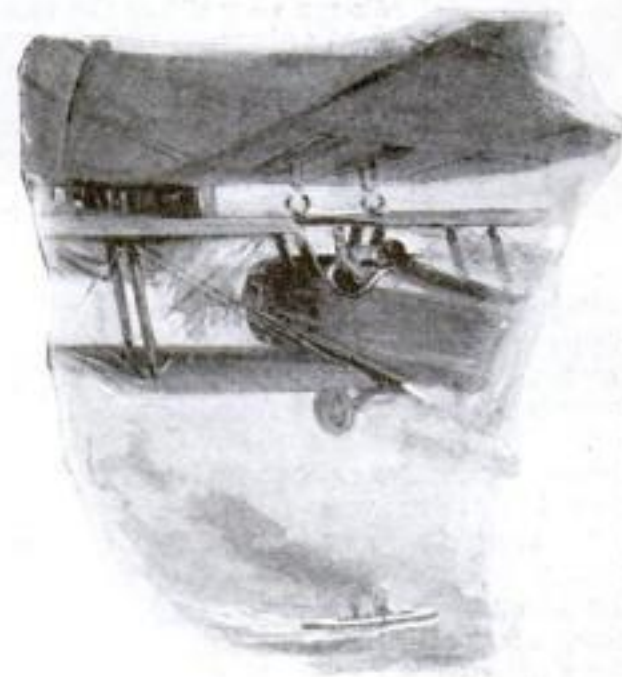


The 300-foot semi-rigid army airship "R-1" as she will appear when completed, with scout planes suspended from her rigid keel as explained below, and with navigation car forward and two power cars aft, side by side



Cross section of the semi-rigid "R-1," showing double envelope that will inclose helium filled balloonets, and rigid, three-cornered framework keel of duralumin that will run the entire length of the ship

crew of from 16 to 20 men. A telautographic signaling system, by which the pilot can signal the power cars for speed changes, engaging motors, and reversing, will be a feature of the control-board equipment. The propellers will be 20 feet in length and will have 640 revolutions a minute.



Small Electric Motor Shakes Sifter



This sifter is shaken by an electric motor beneath the screen

A NEW electric sifter, which shakes material through a screen at an extraordinarily rapid rate, has a novel eccentric that produces a rapid shaking motion.

The material to be sifted is thrown into a container at the top of the sifter and falls upon a movable mesh screen. A small electric motor beneath the sifter rotates a shaft connected with the screen through an eccentric, imparting a vibratory motion to the screen and causing the small material to be brought over the openings in the middle.

The machine is capable of screening a ton of moist sand in four minutes. It is also used for the purpose of separating the solids from the liquids in various processes used in chemical manufacturing industries.

You Can Make Your Home Safe from Fire

Walls of Metal Lath and Plaster Withstand Blaze for an Hour

WILL you be one of the 15,000 victims of fires in the United States this year?

Will your home be one of the 1600 dwellings offered as unwilling sacrifices to the God of Flames this week?

You can't answer those questions. But, thanks to remarkable progress in the science of fire prevention and fire control, you can help to cut down the \$1,500,000 daily toll exacted by preventable fires in this country, and of which you now must pay your share. You can help to reduce the tremendous cost of fires in human lives sacrificed. And the way you can do it is to observe a few simple precautions to safeguard your own life, the lives of your family, and your home.

Homes Protected at Small Cost

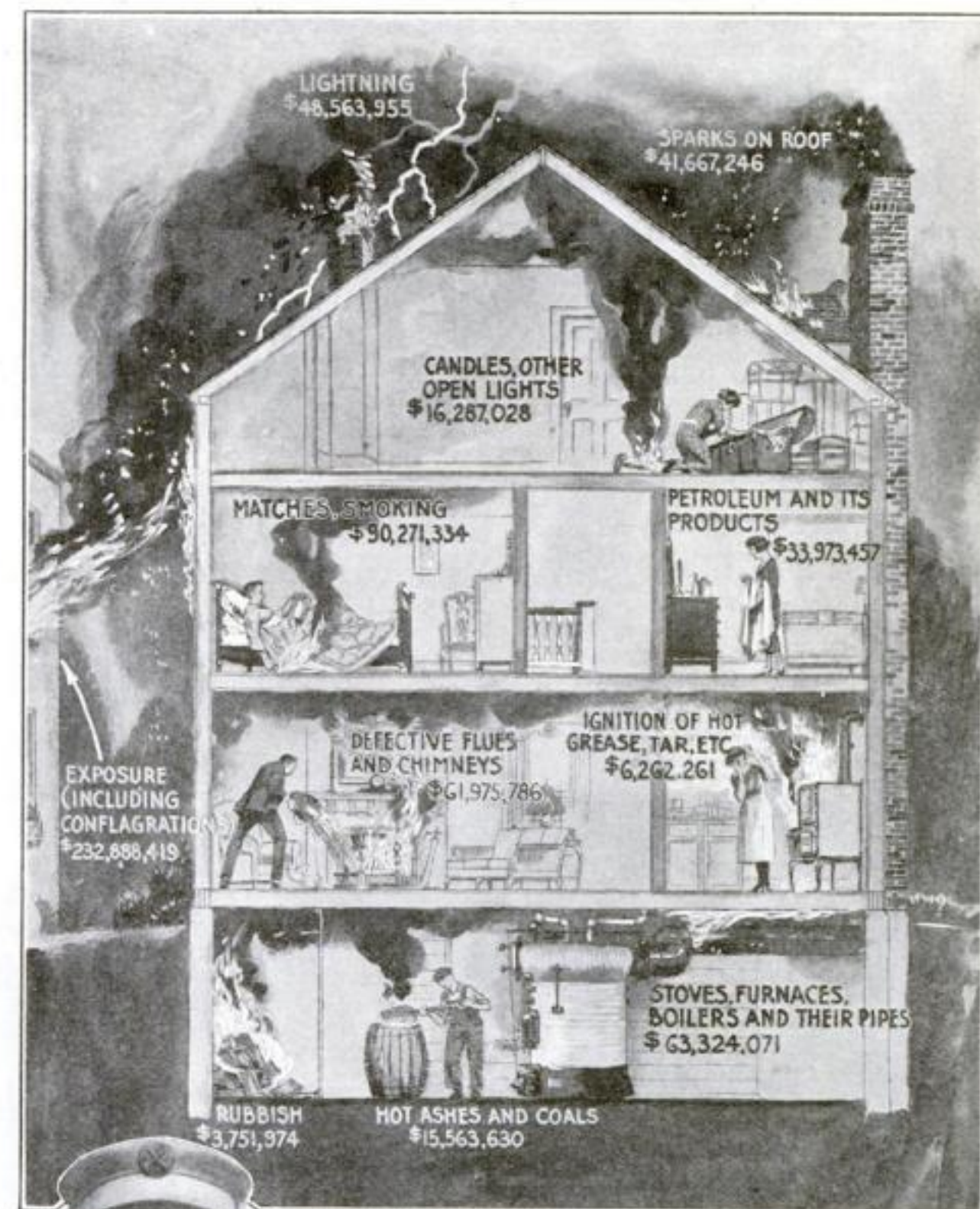
By the most authoritative and complete fire tests ever attempted, the Fire Underwriters' Laboratories of Chicago, Ill., have proved that we can make the ordinary frame dwelling almost completely fireproof. Obviously, we cannot reconstruct the homes in which we now live, but we can make certain simple, inexpensive improvements that will make them far more fireproof than they are now. And if we are building new homes, we are assured that fireproof construction will not entail additional cost.

Fire is the world's greatest peace menace. The United States spends yearly \$283,000,000 (nearly enough to build a Panama Canal) to replace fire losses. And a very large percentage of this loss results from fires in homes. The problem of confining fires to the buildings in which they start has been practically solved as the result of careful education in building, increased vigilance and efficiency of fire departments, and modern fire fighting methods. The important problem now is that of confining fires to the rooms in which they start. This may be accomplished, experts tell us, only by thorough education to eliminate common acts of carelessness, use of materials advised by those who make it their business to examine fire risks, and actual replacement of hazardous parts of our homes.

New Fireproof Building Material

In response to a growing demand, engineers now have developed a fireproof material for home construction that, in exhaustive tests, has proved to be an entirely adequate safeguard. This material consists of plaster of Paris (or gypsum) and expanded metal sheeting or lath. Several coats of the gypsum plaster are applied after the sheeting is nailed to the studding in the same way that laths are now put up. The sheeting tested and approved is three-eighths-inch diamond mesh such as is now used for stucco work on the outside of houses. It serves to support the first, or "scratch," coat of gypsum and sand mixed in the ratio of one to one. The second or "brown" coat consists of fibred or sanded gypsum in a ratio of one part gypsum and two parts fine sharp sand. The third, or finishing coat, is a mixture of three parts lime putty to one part dry calcined or burned plaster.

Neither the materials nor the method of



The most common causes of preventable fires that destroy 1600 dwellings every week in the United States and the consequent loss in dollars over a period of five years are indicated above

Fire Buff Gives Advice on Fire Prevention

ONE of the queerest hobbies in the world is that of Robert H. Mainzer (at left), a Wall Street broker whose lifelong avocation has been attending every big fire in the city.

More than a score of prominent New Yorkers have the same fad. They race off to fires with the enthusiasm of schoolboys, and the name of "fire buff" was invented to describe them.

But Mainzer is the champion "fire buff" of them all. He has in his home a special fire alarm apparatus. When a big blaze breaks out, he drops everything to rush to the scene, and he works as hard as any of the firemen there. Having seen 4353 three-alarm fires, and inspected fire departments in most of the world's greatest cities, Mainzer speaks with intimate knowledge of fire prevention problems. He says:

"Carelessness, inadequate construction, and incendiarism, are the three chief causes of fires. Innumerable fires from the first two causes could be prevented, if we took simple precautions. The fire peril is so grave in the nation today that every person should give thought to it, and teach fire prevention methods to his children."



application are patented, and a wall or ceiling can be constructed by any plasterer at a cost no greater than that of ordinary plaster or cement. The metal is manufactured by steel companies for other purposes or expressly for use in fireproofing

homes. The plaster of Paris is derived from gypsum, a common mineral, by a process of heating that removes the water contained in the mineral. It can be obtained and applied by any builder.

In the tests performed by the Under-

writers' Laboratories the material was in the form of a ceiling and a wall. For the wall test, a double wall was constructed consisting of two by four inch studding spaced 16 inches apart. Upon these was nailed the metal sheeting. Gypsum plaster was then applied to both sides of the wall and the entire 10 foot by 12 foot frame was placed in a gas furnace in such a way that the flame had access to one side, while the other side was unexposed. Thus conditions similar to those to which a wall would be subjected in an intense fire were produced and the results were analyzed.

A Barrier to the Flames

When one of the slabs thus tested was exposed to the flame for $4\frac{1}{4}$ hours, the thermometers on the unexposed side of the wall registered an average of 263° F., while the temperature of the side exposed to the flames averaged 2030° F.

A second slab was subjected to both fire and water, the flames beating upon one side for an hour, after which the slab was withdrawn and subjected to the force of a $1\frac{1}{8}$ -inch stream of water. The wall was practically destroyed, of course, yet not until it had withstood the extreme onslaughts of fire and water for an hour.

This "time rating" of one hour was far greater than any rating ever given to walls constructed of other materials.

The ceiling test was performed by constructing a ceiling of these materials over a



A section of rigid metal lath nailed to studding as reinforcement for plaster or stucco is effective fireproof construction of walls or ceilings

furnace and loading the ceiling with bricks to imitate the conditions that actually exist when a ceiling bears the load of a floor above. The "time rating" again was extremely high, although, as in the wall test, the ceiling was eventually destroyed. By these terrific fire tests the experi-

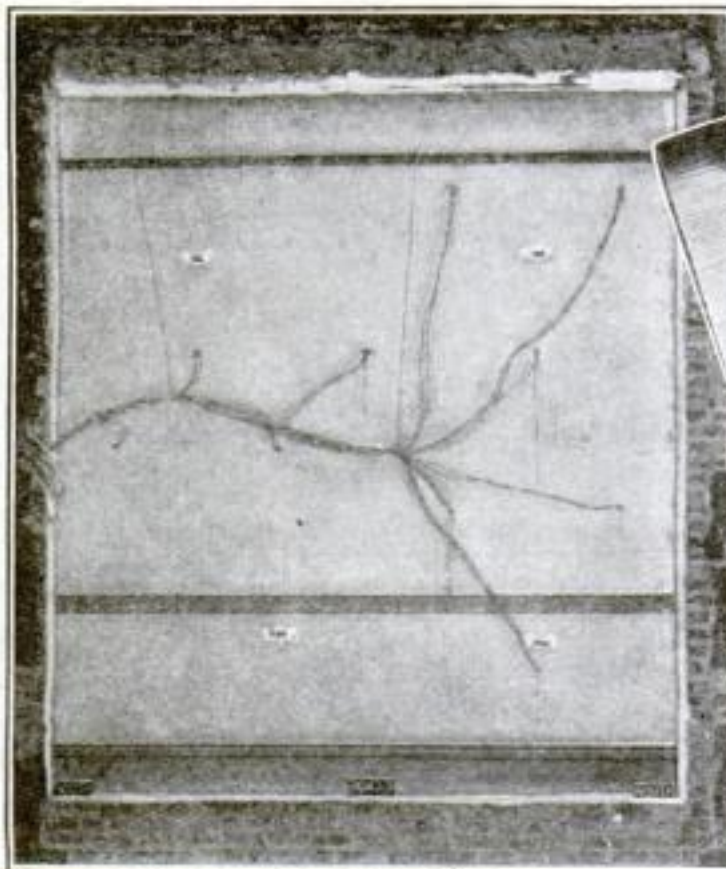
menters effectively demonstrated that if a fire should gain headway in one of the rooms of a home inclosed by fireproof walls built of the materials tested, the blaze could be confined to that room for more than an hour without danger of its spreading to other parts of the building.

Where Metal Lath Gives Safety

By slight alterations, vulnerable parts of our homes may be made fireproof with these materials. Metal lath can be used over the furnaces, in closets, around flues, staircases, bearing partitions, and the inhabited floors at a cost less than the interest charge for four months' occupancy—and give safety nearly equal to that assured by complete fireproof construction.

In addition, all of us should see that our homes are roofed with incombustible materials. We should safeguard floorings where steam pipes pass through by fitting metal collars on the pipes, place asbestos boards above furnace pipes that are too close to beams, and see that all electrical circuits are installed in approved conduits.

Finally, we must guard against carelessness, which is the greatest cause of fires, by disposing of matches, cigarette and cigar butts in metal receptacles, keeping our basements clear of rubbish, using metal containers for ashes, using non-inflammable materials for cleaning purposes, and properly protecting our homes with lightning rods. These precautions will assure safety.



THESE illustrations show how walls constructed of gypsum plaster reinforced by expanded metal lath would confine a blaze to one room for more than an hour.

At left: Unexposed face of fireproof wall slab after the opposite face had been exposed to fire for 75 minutes. Note electric wires to recording thermometers.

At right: Exposed face of the same slab.

Above: Section of the wooden studding.



This Large Capacity Truck Was Built from a Tractor

CONSTRUCTED by combining a Fordson tractor with the wheels obtained from a large steam tractor and mounting a wooden body on them, a homemade large capacity truck is being used by a contractor of Athens, Ontario, Canada, for the purpose of hauling stone from a crusher and distributing it along a road that is being built.

The rear wheels are chain driven from a jackshaft at the rear of the tractor trans-



How Fordson tractor was combined with steam tractor wheels

mission and are wide enough so that the truck can negotiate soft and muddy country roads while carrying a couple of cubic yards of crushed stone.

Simply by removing a panel at the rear of the truck, the load can be dumped. The owner was obliged to build his own machine because he could find no truck on the market capable of hauling similar loads over the rugged country where most of his work was situated.



New Instrument Is Played with the Feet

A MUSICAL instrument built on the principle of a piano, but in which the keys operating the sound-producing mechanism are pressed by the feet of the player, has been invented by a Western musician. The strings of the instrument are mounted on a vertical frame inclosed in a wooden case. The keyboard is placed at the bottom of the case.

There are eighteen pedals. Nine on the left side of the keyboard represent tones of the chromatic scale beginning with G below the middle C of the piano; the nine pedals on the right produce chords. Shifting of the key is effected by stops that reach across the strings and are also operated by the feet. All pedals are pivoted on the same fulcrum bar, separated by friction pads.

The tonal range of the instrument is too limited to make it suitable for solo work, but it supplies a satisfactory accompaniment for strings or voice.

The Editor will be glad to supply, whenever possible, the names and addresses of manufacturers of devices mentioned in this issue of POPULAR SCIENCE MONTHLY.

Corncribs Made of Chicken Wire



Around poles driven in a circle are fastened sections of wire fencing, forming graincribs. Roofs are of cornstalks

Paver Lays Road Automatically

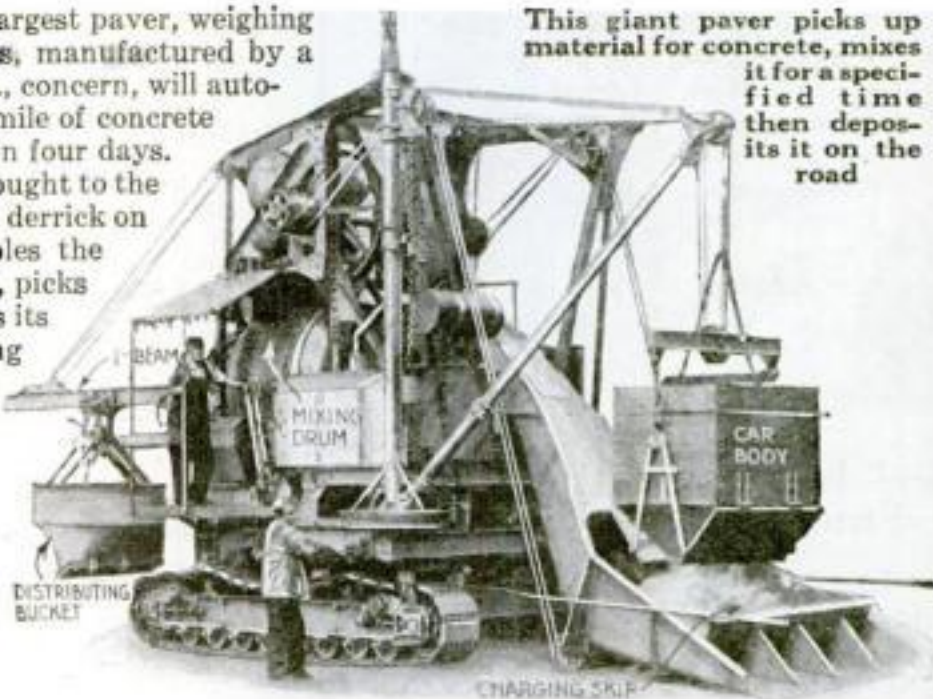
THE world's largest paver, weighing over 30 tons, manufactured by a Milwaukee, Wis., concern, will automatically lay a mile of concrete road pavement in four days.

Material is brought to the paver in cars. A derrick on the paver grapples the body of each car, picks it up and deposits its load in a charging skip. The skip then rises while the car body is being replaced, and the batch is deposited in the mixer, which has a capacity of 60 cubic feet of material.

At this point a valve is automatically opened and the proper amount of water enters the mixer. A clock mechanism, called a "batchmeter," starts to operate with the mixing drum and locks the discharge mechanism so that the material must remain in the drum for a full minute. The batchmeter also counts the number of batches mixed.

After the mixing time has elapsed, the operator unlocks the discharge

This giant paver picks up material for concrete, mixes it for a specified time then deposits it on the road



mechanism and the concrete flows out of the drum into the distributing bucket. The operator sends out this bucket to where he wishes to deposit the concrete, reverses the bucket and allows the concrete to flow out, while the bucket returns to its original position. The rate of return is so regulated that the amount of concrete left in one position is just enough to make a slab of the desired thickness.



Bathbrush Holds Soap

THE latest bathbrush has in the center of the bristle side a space large enough to hold a cake of soap. The soap is held by a clamp that can be adjusted by a screw on the back of the brush as the soap becomes smaller from use.

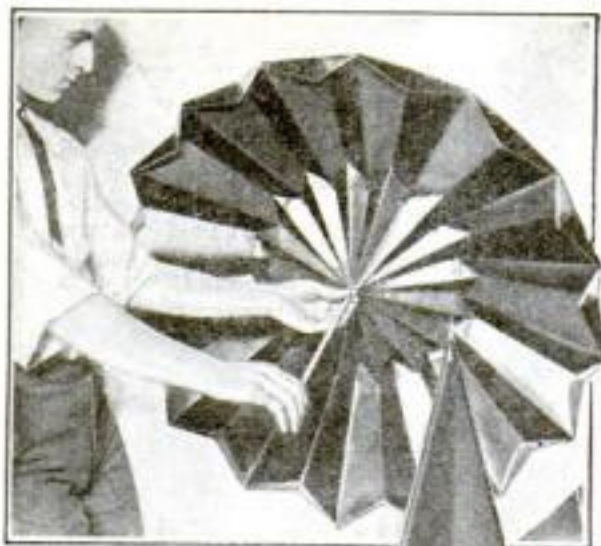
This Pocket Camera Is only Half an Inch Thick

EXTREMELY compact, yet combining the most improved features of a large camera, a pocket camera recently perfected is only a half inch thick when collapsed. It is equipped with a long bellows extension, permitting the photographer to take pictures as near to the objective as a foot and a half. The rising and falling front permits photographing of tall buildings without tilting the camera, and without distortion.

Despite its small size, the camera may be fitted with almost any high grade lens.



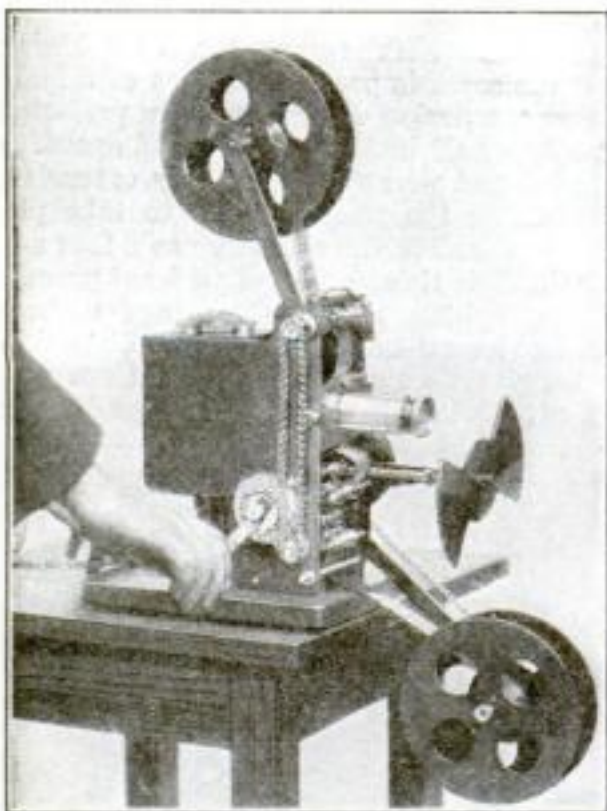
Above, the camera opened, showing long bellows that permit photography at close range. When closed, the case is only half an inch thick and may be slipped into a narrow pocket as shown at right



Paper Umbrella for Emergency

A COLLAPSIBLE paper umbrella that is serviceable and attractive has recently been designed and patented as an inexpensive emergency shelter for the traveler who is caught in a shower.

The umbrella is made of waterproofed paper and consists when open of two cones, the inner one of which acts as a brace (corresponding to the ribs in the ordinary umbrella). When collapsed, the umbrella is flat, resembling a bellows in shape, and can be packed in a suitcase or under an auto seat. The umbrella will withstand a 30-mile wind.



Small Projector Provides Movies in the Home

WITH a small and inexpensive home motion picture projector recently devised, any household may enjoy the best movie productions and the most popular film stars without going to the theater. The film reels used with the projector are faithful reproductions of the original feature releases. It can be bought for \$35.

The films are of non-inflammable type and can be bought from the producers and exchanged just as original feature pictures are bought and exchanged by theaters. Thus any film reel, after it is purchased, can be exchanged with little added expense and the home can be supplied continually with movies of the most prominent stars.

What Do You Want to Know?

Send your questions on subjects of general or applied science to Information Department, POPULAR SCIENCE MONTHLY, 225 West 39th Street, New York City, inclosing self-addressed stamped envelope

Q. Why is the water of the sea salt?

A. Because during millions of years the rains have been wearing down the land and carrying the dust and sand from it into the sea. The solid fragments have been deposited as sand or clay on the sea bottom, but always there has been a little of the rock from the land that was really dissolved by the water and remained in solution. This is the salt of the sea, and the quantity of it has gradually increased during geologic time.

and determining which chemical elements compose the glowing substance from which the light comes. Each chemical element gives out its own particular kind of light.

Q. Are there any creatures that live forever?

A. Scientists believe that certain one-celled animalcules do. These tiny creatures live in fresh-water ditches and similar places. When they have grown to full size, they divide in two, and when each half grows to full size, it divides again, and so on indefinitely.

Q. What is hypnotism?

A. A mental state in which the attention becomes so much fixed on some single thing or person that nothing else is perceived. If you are climbing down a fire-escape on a burning building, you can cut your finger without being conscious of it at all. This is a form of hypnotism. Your attention is fixed on the fire. When some one has hypnotised you, your attention is fixed on him, to the exclusion of everything else.

Q. Why isn't the air all used up by the breathing of men and animals?

A. Because as fast as the oxygen is taken out of the air by animals, it is put back into it by plants. The green plants take out of the air the carbon dioxide exhaled by animals, and by retaining the carbon release the oxygen, which returns to the air. The plants use the chemical power of the sunlight in doing this, and by the same process produce sugar or starch, to be stored up for future use.

Q. What is the duty of the white corpuscles in the blood?

A. These tiny white cells, which accompany the ordinary red corpuscles in the blood, are supposed to be scavengers—the street-cleaning and waste-removal department of the body. They also defend the body against attack. When a dangerous germ gets into the blood, they surround and destroy it.

Q. Why are soap bubbles round?

A. Because of what is called surface tension. This is really a form of cohesion, the force that keeps everything from flying apart. Iron is held together in a solid mass by cohesion. A falling drop of water is round because that is the most compact form it can take, the form that agrees best with its cohesion. So with a soap bubble. It takes the most compact form it can, of course, without allowing the air inside to escape.

Q. How do we know what the stars are made of?

A. By means of the spectroscope, which is an instrument for analyzing their light

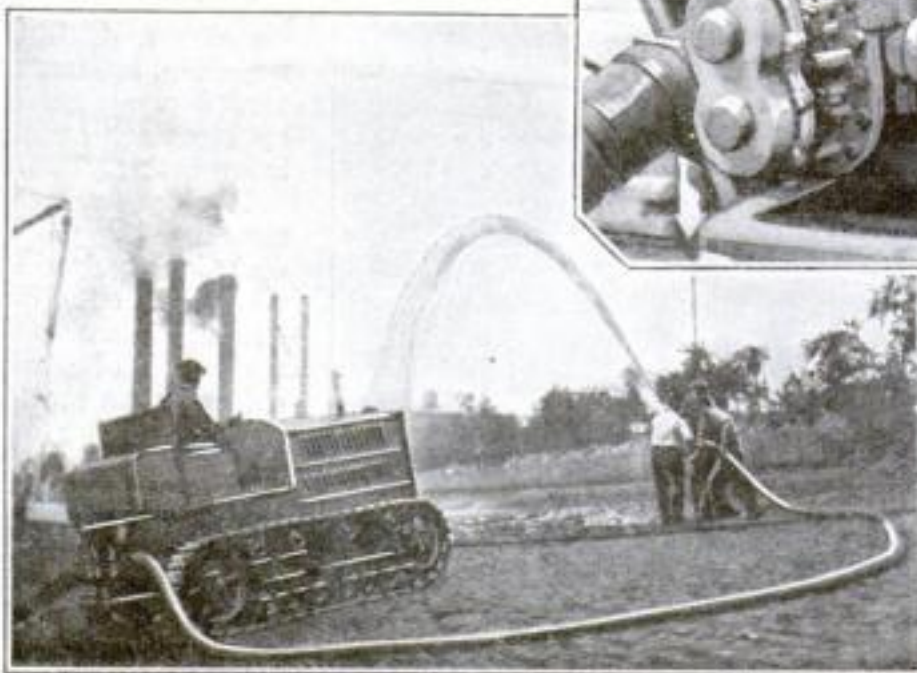
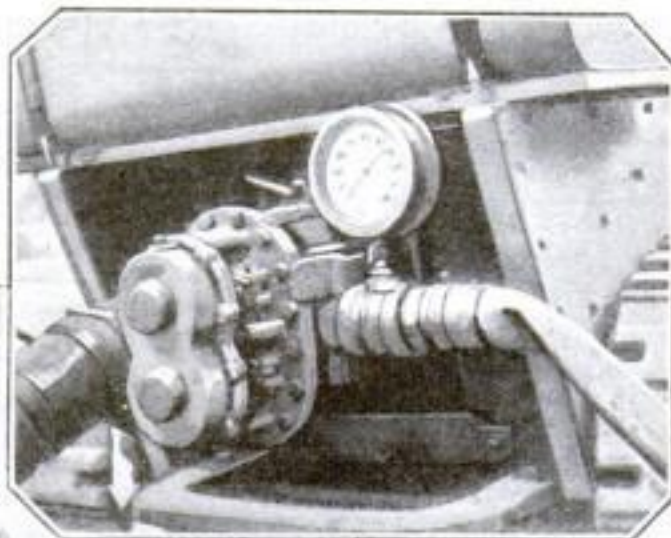
Tractor Drives Powerful Fire Pump

DESIGNED for forest fire patrol and for municipal fire protection, a rotary rear wheel pump attached to a track-laying tractor is performing excellent service. It is adapted also for use by contractors in pumping out flooded excavations, trenches, or coffer dams and as an auxiliary for irrigation work.

The pump is driven through the countershaft direct from the tractor motor and is capable of delivering 200 gallons of water a minute under a working pressure of 100 pounds to the square inch. At normal speed it throws a 1 1/8-inch stream 100 feet in the air, requiring 26 horsepower. Its chief advantage, especially in forest fire patrol, is that it can

travel speedily over the roughest ground.

With working parts inclosed in a heavy cast iron case, the pump is attached at the extreme rear of the tractor. Its efficiency is enhanced by the fact that the pump gears are driven from the motor shaft through closely fitted spur gears running in an oil bath. These gears take the entire driving load. The attachment weighs 225 pounds.



Attached at the rear end of the tractor, the pump is driven from the motor shaft through spur gears. Its capacity is 200 gallons of water a minute and it will throw a 1 1/8-inch stream 100 feet in the air.

Would a Falling Bullet Kill You?

It Might Give You a Headache, Says Army Captain Who Describes First Scientific Tests Revealing What Happens When a Bullet Is Shot Straight Upward

By Capt. Edward C. Crossman
Late Fire Control Officer, Small Arms
Ballistic Station, U. S. A.

ON THE shelter platform, above our heads, the Browning machine gun remarked 10 times, staccato: "Tat-tat-tat-tat," while three stop watches clicked with the first shot, and commenced their busy ticking. Above us two machine gunners ducked under the cover of their extemporized steel shelf, while we stood in security beneath half an inch of armor plate covering the 10-foot-square platform of the observation tower.

The first burst of shots in the first scientific attempt ever made to find out exactly what happens when you fire rifle cartridges straight upward into the air, had just gone, and we waited to see what would happen.

Around our tower—four piles driven into the mud of a Florida lagoon, with platforms built over the piling—there stretched open water for hundreds of yards, all quiet, except for the little ripples stirred by breezes.

We stood perfectly quiet, ears alert for the splash of the returning bullets if the machine gun volley should return within earshot. Then, when the hands of the stop watches had just crossed the 50-second mark, there came a queer whirring whistle. A hundred yards or more away, something was throwing up sharp splashes on the quiet water. The 10 shots from the Browning were returning. The time from first to last shot was about four seconds.

So began a remarkable series of tests that proved conclusively that not one of the several types of rifle bullets has power enough, on its return trip to earth, to bury itself more than two thirds of its length in firm sand; nor could it inflict a serious wound if it should strike a man's head incased in any fairly firm headgear—in fact, it probably could do no more damage than to cause a headache.

Another volley from the Browning, and this time greater luck was with us. Although the bullets in this burst projected probably 9000 feet into the air, and traveled for about one minute up and one down, they fell all about the tower. And as they

fell there came a yell of exultation from the machine gunners above, following a heavy "clang" and a splash of water.

"I caught it in me bucket! How's that for shootin'?" yowled a machine gunner. Sure enough, one of the returning bullets had struck fairly in a galvanized pail of water on the platform near the gun! It had merely made a dent in the bottom of the pail. Another bullet struck the pine boards of the platform where they extended slightly beyond the armor covering, making a dent about a third of an inch deep, with the diameter of a lead pencil; but the bullet did not even stick in the indentation.

In these tests we used the standard infantry and machine gun cartridge of the American service, bullet of 150 grains, velocity 2700 feet. But when we tried out the 175-grain boattail bullets—a remarkable new type with tapering tail that doubles the range of a rifle—

some of us nearly came to grief. After a minute and seven seconds there came the bullet whirr, louder than that of the service bullet, and then the usual splashes on the surface of the lagoon. Then the splashes ceased, although not all of the bullets had been accounted for. Some of the gunners had stepped out of their shelter, and the watches had been stopped—when suddenly—certainly half

a minute after the burst had landed, there came again the bullet whirr. Machine gunners ducked for shelter—and down whirred eight or 10 more shots.

Whereupon we discovered an astonishing fact—that when fired from a machine gun, boattail bullets vary widely in their time of flight. In the next burst we found that the bullets re-

Conducting the world's first scientific tests to determine exactly what happens when a rifle bullet is shot straight upward, Capt. Edward C. Crossman discovered astonishing new facts about the rise and fall of the regulation army rifle bullet shown at right, revealing that a falling bullet, if it hit you, probably wouldn't cause anything more serious than a headache

turned in a cluster in about 67 or 68 seconds, while a second group returned fully 40 seconds later. Later we repeated this sort of firing on the hard sands of Daytona Beach, Fla., and found that the boattail bullets were as likely to return to earth sideways as to fall as most bullets do—base first. This led to the conjecture that the time discrepancy is due to the way they turn

and travel on their return flight (a sideways flight resulting in increased air resistance), and that the variations may be due in part to vibrations in the machine gun.

Normally, when fired vertically, a bullet of any sort returns in the position in which it went up. If you fire it normally, point first, it returns with the point still upward and the base downward. If you invert it in the shell and fire it with the point down and the flat base up, it returns point down and base up, but in much shorter time than the bullet normally fired.

We tried out various types of guns and bullets in this vertical firing. The results showed that almost any bullet fired into the air remained away 30 seconds or more. The little .22 long rifle, with its 1000 or 1100 feet a second velocity, took 35 seconds. The large, slow .45 automatic pistol bullet took 39 seconds. The .30-30 bullet took 50 seconds, or nearly as long as the service sharp point. The Remington .35 auto-loader bullet, 200 grains at 2000 feet a second, took 58 seconds. The quickest trip recorded was that of the 175-grain boattail, which was loaded inverted. It returned in 21 seconds, as compared with 67 to 107 seconds when fired normally.

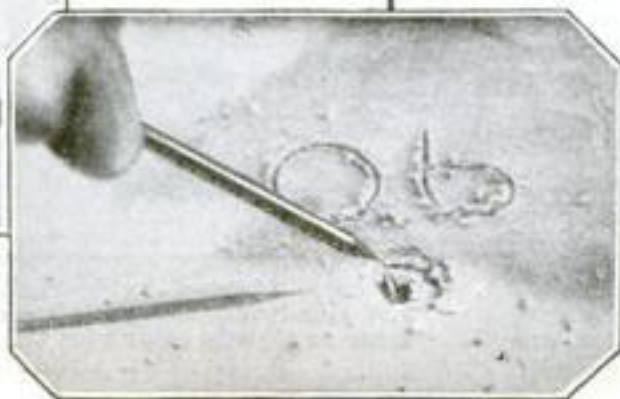
Not one of the rifle bullets tested returned to earth with power enough to bury itself more than two thirds of its length in the sand

This 175-grain boattail bullet remained in the air 67 seconds; yet others of the same type, discharged at the same instant, stayed aloft 107 seconds, or 40 seconds longer

This 150-grain army service bullet went up nearly two miles and was gone 49 seconds before it returned, tail downward, to dig itself into the sand as shown below



From a machine gun mounted on the top platform of this tower, bullets were fired straight upward. Half-inch armor plate covering the lower platform protected observers from returning missiles



Professor Braves Death to Prove Dread Spiders Are Man's Friends

Induces Huge Tarantula to Bite Him—and Lives!

WOULD you have the nerve deliberately to force a "deadly" tarantula—that dreaded hairy spider often as large as a man's hand—to nip your finger, in order to test the supposed fatal effects of its poison?

Professor W. J. Baerg, a scientist of the University of Arkansas, recently summoned his courage to try just such a daring experiment on himself. And because he lived to tell the tale, he added convincing proof to the accumulation of recent scientific evidence that the tarantula—popularly supposed to be a death-dealing enemy of man—is really about as harmless as the more familiar spiders that protect us from hosts of harmful insects that might infest our houses, in whatever country we live.

Professor Baerg's experiment was made when, on taking up his new post in the University of Arkansas, he heard exciting tales of the "horrible," hairy Arkansas tarantula, which was said to attack unwary human victims with a lightning-like leap, and to strike with poison fangs that almost always meant death. Professor Baerg tested the effects of a tarantula bite on a rat, and found that while the victim went into a prolonged state of coma, it survived.

Taking His Life in His Hands

Then he induced an unusually large tarantula to strike him twice on the inside of a finger. The second strike perforated the skin and caused blood to gather. The sensation of the bite was like the prick of a pin, and the poison caused the finger to swell a little; yet no trace of pain remained after two hours.

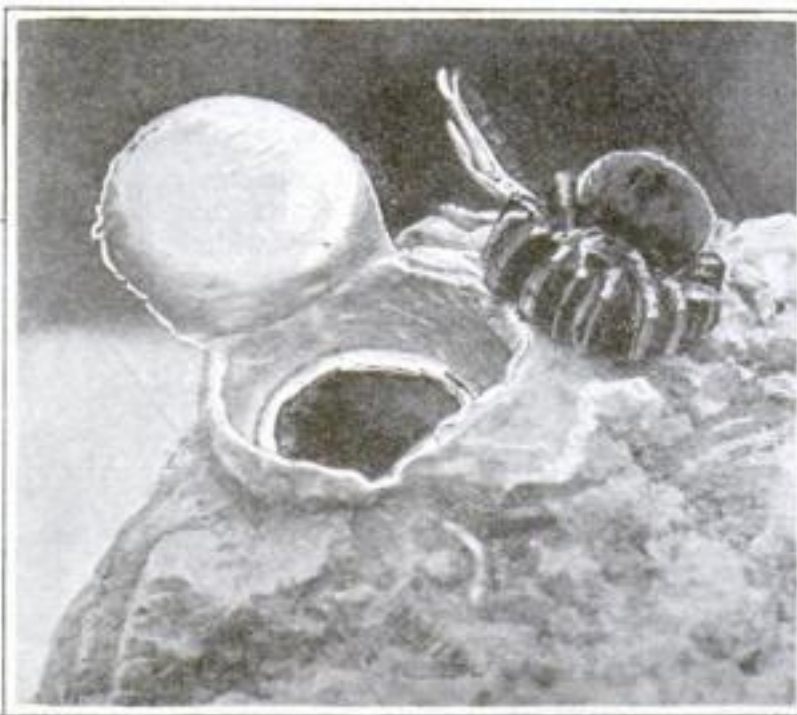
The experiment was repeated, the tarantula being induced to strike savagely, excreting more poison than before.

Thus was shattered one of our apparently well-grounded beliefs about spiders. For example, people generally take it for granted that the spider is an insect; yet, in fact, the members of the spider family, including the tarantula, are far more closely related to the lobster and shrimp than to insects. Spiders possess eight legs in most cases, while the insects have but six.

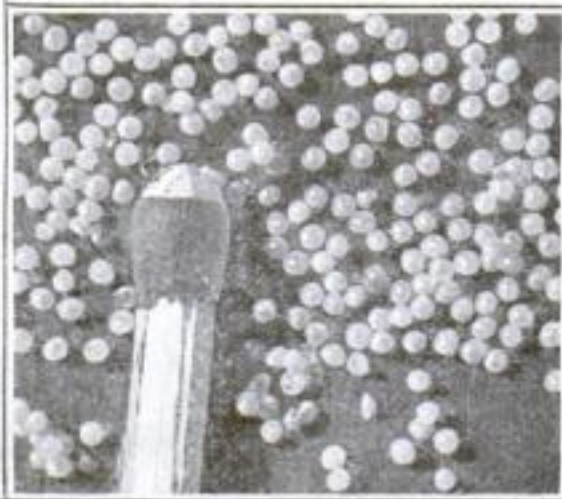
"Spiders do all in their power to



How some spiders come to grief. This wasp's nest, broken away, shows how captured spiders are stored for food



When the trapdoor spider, shown above, enters his silk-lined burrow, he closes the hinged door so tightly after him that not even a crack is visible



Spiders' eggs compared in size with a match head. A female spider sometimes lays as many as 500 of these eggs



Photo Courtesy American Museum of Natural History

avoid aggressive contact with man," says Paul Griswold Howes, authority on insect life. "They come about our houses for the flies and other

insects that are attracted there also, and in this way continually work for our benefit. Even the great and dreaded tarantula of South America is among the beneficial spiders. I have seen them in camps, remaining hidden during the day and venturing forth by night, to prey on the gigantic roaches that infest the houses. They grow

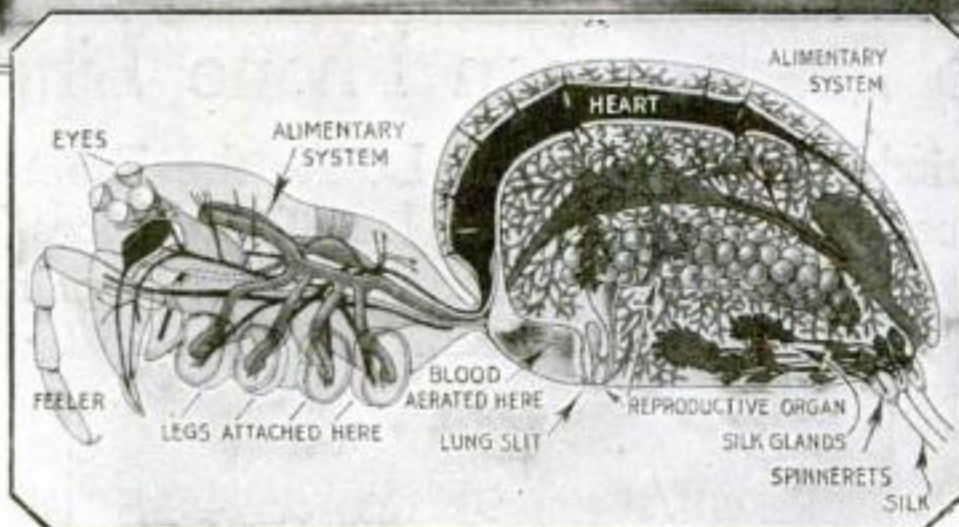
to enormous size, but the people in these countries do not often kill them, because of their predatory habits. In British Guiana, I have lived peacefully in a shack containing a dozen or more tarantulas. They never disturbed me as long as I treated them in a like manner."

This naturalist attributes cases of illness resulting from tarantula bites to poor condition of the blood of the person bitten, and affirms Baerg's statements that the bite of the most "deadly" spider need not cause more

Braving possible death to prove that the dreaded tarantula is not deadly, Prof. W. J. Baerg, of the University of Arkansas, induced one of these hairy monsters, shown in actual size above, to sink its fang into his finger. The wound caused a slight swelling of his finger, but that's all the damage it did



Can you blame the fly, caught in the meshes of a spider's web, if it is terrified when this hairy ogre approaches? Here is a remarkable close-up of the harmless common house spider that pounces on harmful insects that invade your home



Scientists tell us that spiders may be said to be nearer to the crab family than to the insect family, in which people generally class them. In the cross-sectional view of the spider's anatomy, at left, note the crablike feelers

than a few hours' pain, if the victim's blood is in normal condition.

Spiders are usually fascinating creatures for their strange habits, their business of spinning webs, and their ability to excel in the art of camouflage. One of the most ingenious of the family is the hairy black trapdoor species, found in our southern and southwestern states. This powerful spider's home is a burrow constructed of clay—a tube, lined fantastically with silk webbing, and fitted with a hinged door so perfectly adjusted that when it is closed, not the slightest crack can be detected from above. When frightened, the spider runs into this tube, shuts the door behind, and remains in safety until danger is past.

In one of our most common families of spiders the female imitates Indian squaws. She carries an egg case on her back, and the young, when they emerge, are carried by her like Indian papooses, until they are well grown.

Amazing Facts of Spider History

In the process of evolution, some spiders have developed to an amazing degree their "instinct" of cunning and camouflage, for self preservation. One species that will deceive even the sharpest eyes resembles the excreta of a bird—a resemblance that has been gradually developed through countless years of natural selection.

Sexes of spiders are distinct, and the female of the species unquestionably is more dangerous than the male. The male usually does his wooing cautiously, fearing to arouse the anger of his mate, who is large enough to annihilate him. The number of eggs produced by the female varies, according to the species, from half a dozen to hundreds. Immediately

after laying her eggs, the female constructs about them a cocoon of silk, in some cases carrying this cocoon about with her, and in others keeping it in the silken nursery within the burrow, or attaching it to the stalk of a plant.

Professor Baerg observed that one female tarantula he captured had constructed a large silken bag about the size of a black walnut. She spent practically all of her time sitting on the bag and when this was removed a few weeks later, it was found to contain 113 young spiders and 460 eggs. Further examination convinced him that the young spiders subsisted on some of the

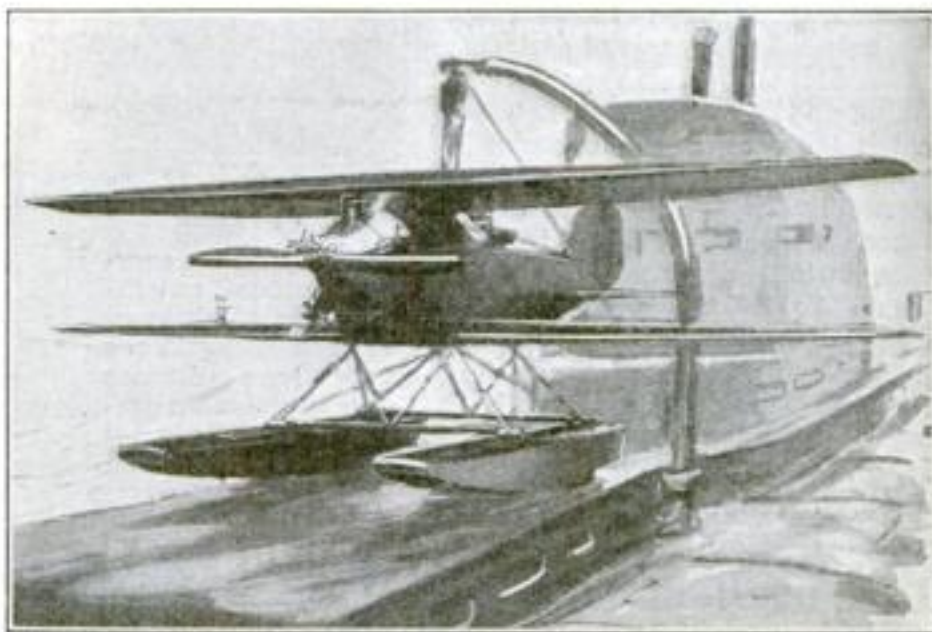
eggs that apparently were unfertile. Baerg also thoroughly established the fact that spiders are cannibalistic in nature

when in desperate need of food. Wasps are the arch enemies of the spider, capturing them almost at will and carrying them off to their "adobe" homes. In some of these homes have been found as many as 30 spiders being prepared as food.

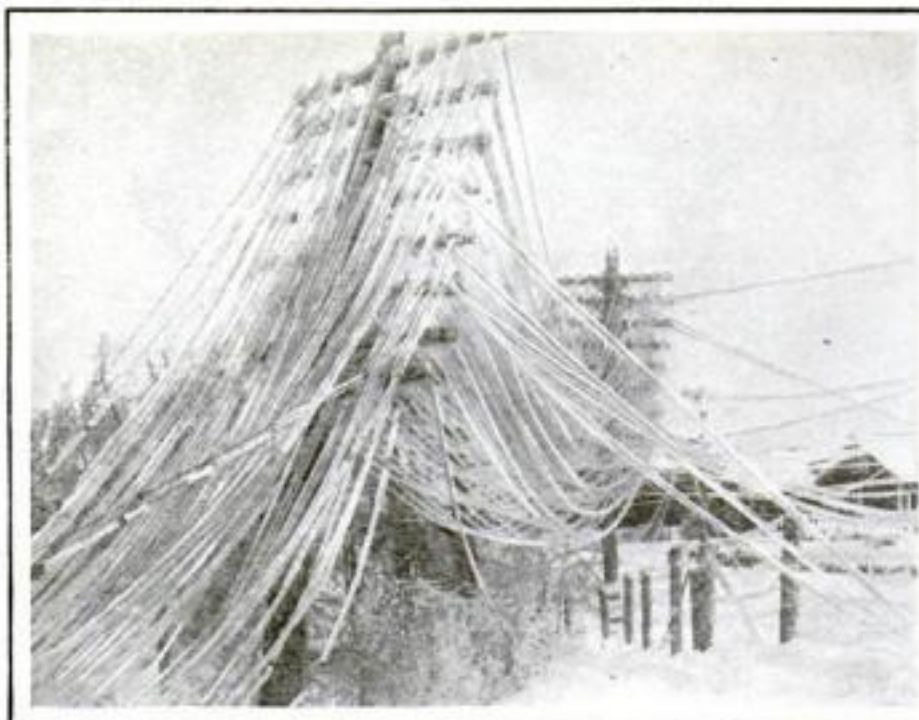
In web spinning the spiders' skill is amazing. There are hundreds of types of these webs, the most common being circular in form. The spider, at the center, uses a sort of telegraphic system to locate a fly caught in the meshes, the vibration set up by the fly's struggles communicating itself to the nearest radiating thread and thus to the center.

Seaplane Launched from Submarine

THE invention of a small seaplane that can be stored in a submarine, assembled on the deck in five minutes, and launched, provides a new weapon of attack. The seaplane has a wing spread of only 21 feet. It can be knocked down and stored in a four-foot hold of a submarine.



Launching the seaplane from deck of submarine



Extraordinary scene along a telephone line during the destructive ice storm that recently paralyzed communication in the New England states. More than 3700 poles and 3000 miles of wire went down under the weight of the beautiful ice mantle. Drizzling rain followed by freezing weather causes disasters such as this



When wires break under tremendous loads of ice, as shown above, marvelous instruments in the central telephone exchange instantly locate the points of trouble along the line, directing an army of repair men in their work of quickly reestablishing communication. Usually the tangled and broken wire is practically worthless

Bridging the Storm when Phone Lines Go Down

How Marvelous Switchboard Instruments Locate the Exact Spots where Wires Break and Poles Fall under Tons of Ice—Our Voices Take a Detour while Army of Workmen Rushes Repairs

By Harry A. Mount

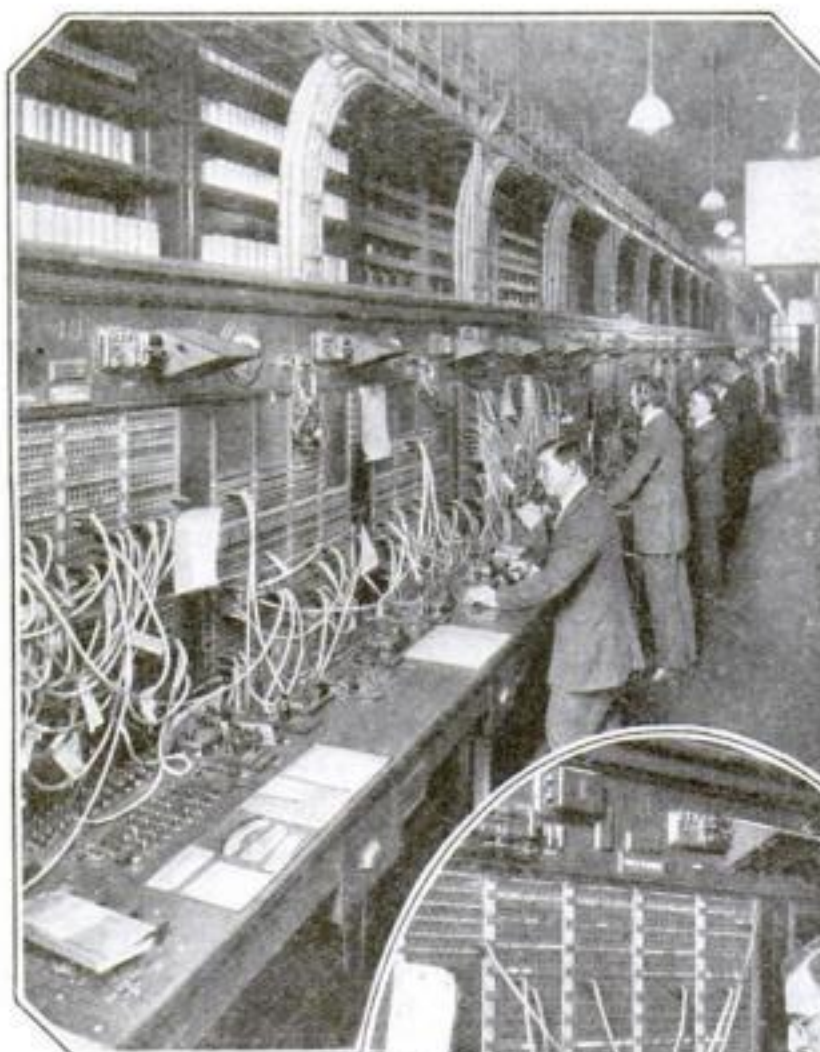
WHEN sleet and ice turn the world into a glittering fairyland, and telephone lines go down under the weight of the frosty tinsel, there swiftly comes to the aid of American telephone companies an amazingly sensitive, almost human, mechanism, that immediately puts its finger on the breaks and skilfully directs the work of repair so that our telephone communications may be uninterrupted by the winter storm.

Switchboard a Block Long

In every large phone exchange in the United States may be found one of these ever-ready trouble finding systems, and the most intricate of them all is housed in the 23-story long-distance exchange in New York City. Here every telephone line, and most of the telegraph lines to distant cities, run to an enormous switchboard, as long as a city block, where first signals of distress are recorded, and where the work of patching up the breaks begins. The board is literally a "nerve center" of communication for a vast area surrounding America's greatest city.

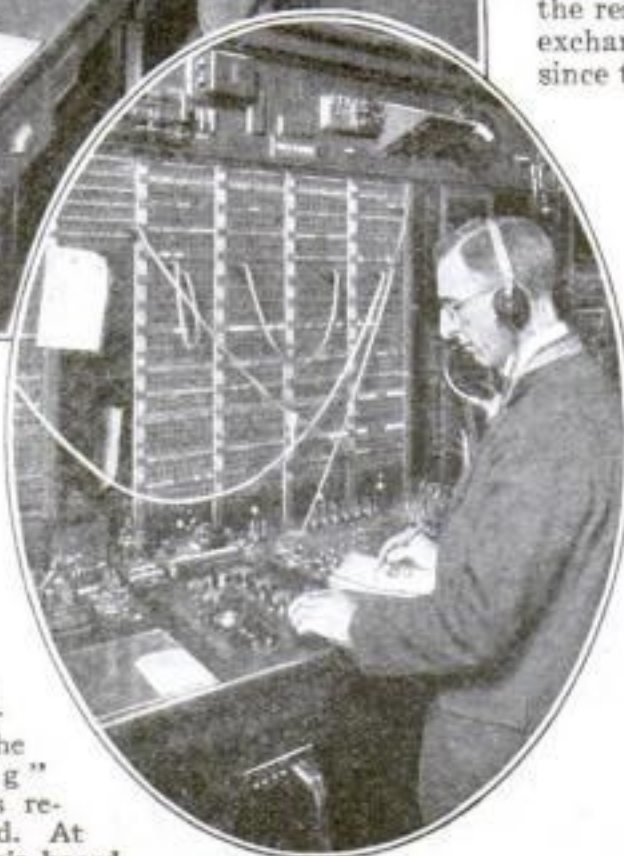
When a winter "ice storm" breaks, no longer is it necessary for linesmen to tramp weary miles through sleet and snow to locate broken wires or fallen poles. In the warmth and comfort of the exchange building, the trouble seeker or tester, with sensitive instruments before him, "feels" out along the ice laden wires and spots the trouble to within a rod or two of the place where the break in the line has occurred.

The break found, his first step is



Where Trouble Is Spotted

AT THIS enormous switchboard, a block long, in the New York City long distance exchange, breaks during a storm are instantly recorded, and interrupted circuits are re-routed over unimpaired lines. Note the numerous "patching" cords with which this re-routing is accomplished. At the right: A tester at his board



to route the broken circuit over another line until repairs are made—a step made possible by the fact that by the marvelous methods of modern communication, a single wire is made to carry half a dozen messages simultaneously. The next step is to hurry a repair gang directly to the spot where the break has occurred.

Wheatstone Bridge Finds Breaks

The most important instrument for locating breaks in a telephone line is the Wheatstone bridge, a simple device for the accurate comparison of electric resistances, by which an unknown resistance may be determined from known resistances. The instrument measures the resistance of the wire from the exchange to the point of break. And since the length of wire to each unit of resistance is known, the exact distance to the point of break can be quickly calculated.

The amazing speed with which breaks can be detected and located is illustrated by the following incident:

Not long ago a native of Pennsylvania conceived the idea of stealing a section of copper wire in a lonely spot midway between two towns, and selling his loot for junk.

The instant his pliers nipped the wire, however, the fact was recorded on a test board in New York, the break located, and crews despatched by telephone from the nearest town. The result was that

the thief was caught red handed before he could even load the wire on his wagon.

Small breaks located by the Wheatstone bridge and other instruments of the telephone's nerve center, are easily repaired while service goes on uninterrupted. But when a great storm occurs and line after line goes down, immediate mobilization of repair forces and of spare equipment begins.

Trouble Army Mobilizes

In effect the emergency organization is military. In command is a general, whose word is law. After a hasty survey of the situation, men, materials, and equipment begin to move into the stricken area from every available point. Each of four sectional branches of the telephone company usually keeps a reserve of about 35 miles of No. 12 wire, and 1600 cross arms and fittings for poles. Sometimes even these supplies are inadequate to cope with the damage done by storms.

Sleet and ice cause greater property damage than all other varieties of storms combined. Only last winter, on the day before Thanksgiving, New England was

visited by one of these storms, the second largest in point of damage done in more than 50 years. Broken, twisted forest trees, and a shattered maze of dead undergrowth are mute evidences of the disaster. In that storm 3200 telephone poles went down. Massachusetts, Vermont, and part of Connecticut were cut off from communication with the rest of the world for several days.

Some Famous Storms

In a similar storm in 1914, more than 3700 poles were put out of commission between New York and Philadelphia, and the year before, 700 poles went down within a radius of 50 miles north of Troy, N. Y., from the same cause. Similar storms occur two or three times every winter.

To repair the break which occurred in New England last year nearly 3000 miles of wire was required, and yet within two months the entire system was repaired. Temporary service was restored within five weeks.



Freaks of the Storm—What Are They?

No, they aren't ancient ruins—just ordinary telephone poles loaded with tons of ice during a recent storm in Alaska, exemplifying one of the problems the linesmen are up against



Monocycle Is a Substitute for the Market Basket

A ONE-WHEEL, hand-pushed cycle, the wheel of which incloses a cylindrical container, has recently been placed on the market for transporting bulky books and documents, or as a handy, practical substitute for the housewife's market basket.

To the container, which is fastened at the center of the wheel so that the wheel rim revolves about it, is attached a long curved handle by which the operator pushes the device along the street. The container will carry either solids or liquids.

The rim surrounding the container has a rubber tire. Used as a trailer to a motorcycle or bicycle, the ingenious monocycle provides a ready means of carrying loads weighing as much as 100 pounds.

Steel Bar Bent with a Visiting Card

WHEN you press the edge of a calling card on the top of a steel bar $4\frac{1}{2}$ inches thick and 20 inches long, solidly supported at both ends, will the bar bend? It certainly will, improbable as it may seem. In fact, with a homemade apparatus, you yourself can easily measure the deflection, which is about a millionth of an inch!

The measurement is performed with a simple optical device that consists of two pieces of plate glass at least one quarter inch thick with a strip of tinfoil between them at one edge. These strips of glass are placed on the under side of a piece of angle iron rigidly connected with the billet, the deflection of which is to be measured.

The upper glass is fastened to this iron bar and to the lower strip by an adjustable thumbscrew. The tinfoil keeps the two glass surfaces from contact. A hole through the angle iron over the center of the glass makes the deflection visible.

If you place this arrangement in front of a light, tighten the thumbscrew until the plates of glass are nearly parallel, and look through the hole, you will see a series of alternate light and dark bands crossing the glass. Lay the visiting card on the steel bar, and these bands will move to the left. Press upward from beneath the bar, and they will move to the right.

To measure the movement accurately, sprinkle table salt in the flame. The resulting yellow light will have a wave length of about $1/50,000$ inch. As each light wave produces both a light and a dark band, if the sidewise movement equals the width of one band, the deflection of the bar evidently amounts to $1/100,000$ inch. You

will probably find the actual movement about one tenth of this, so that you are measuring a movement of a millionth of an inch.

The apparatus is based on the undulatory theory of light. The eye sees two groups of rays, one reflected from the bottom of the upper glass strip, the second from the top of



With this simple optical device, deflection of a $4\frac{1}{2}$ -inch steel bar by a visiting card can be measured, even by the layman, to one millionth of an inch

the lower one. These last rays must cross the air space between the glasses, which is adjusted until it is half the light-wave length.

Analyzing the Measuring Process

In this way the two waves meet at the eye crest to trough, and destroy each other, producing a dark band. Where the air space is a full wave length wide, the waves meet crest to crest and produce a brighter band.

THE EDITOR will be glad to supply, wherever possible, the names and addresses of manufacturers of devices mentioned in this issue of Popular Science Monthly.

Pasture Airdromes for the Night Air Mail

NIGHT flying over transcontinental air routes is expected by government officials within the next six or eight months, making it possible to shoot mail through the air from New York to San Francisco within 28 or 30 hours, thus reducing delivery time by four days.

The latest plans of the Post Office Department are for brilliantly lighted emergency and permanent landing fields for mail planes, strung across country at intervals of 25 miles.

A mail service field near Chicago is being used as a laboratory, where all kinds of lighting systems for these fields will be tested. According to a well-planned scheme already developed, each of the landing fields will be lighted by a beacon, placed on a tower 75 feet high. The beacon can be seen from a distance of 35 miles, and will be easily visible to pilots, even at high altitudes. Farmers who lease the fields to the government will be permitted to use them as grazing fields, but will be required to switch on the lights every evening, and keep them burning until the mail flyers pass.

In the center of each landing field there will be two cinder runways, each 150 feet by 300 feet in dimension. These will intersect to form a cross. Their purpose, of course, will be to allow aviators to descend

on a cinder path, no matter which way the night wind may be blowing. At the end of each path will be placed a flood lamp; the one opposite the approach end toward which the wind is blowing will be dimmed or extinguished. The other lamps will light up the cinder paths without blinding the aviator as he lands against the wind.

Below the surface of the ground, at intervals, around the boundary of each runway, will be placed electric lights equipped with heavy protective plate glass hoods. On the permanent fields, hangars will be illuminated by numerous gooseneck lamps,

as well as by "daylight perspective" illumination, to make the structure clearly visible by night and day.

The roof of the new Chicago Post Office has been equipped as a landing field, and other new post offices will be built with the same idea in view.

Each mail plane will be equipped with two strong searchlights for locating emergency and permanent fields, and for making observations. Under the system planned, the average plane will carry 500 pounds, or 22,500 letters, of New York-to-San Francisco mail.



Above: One of the powerful guiding beacons for a landing field, constructed by the U. S. Post Office Department.

At left: A pasture landing field, the farmer driving his stock home, while a helper turns on the lights

Submerged Blowers Propel and Guide Barge

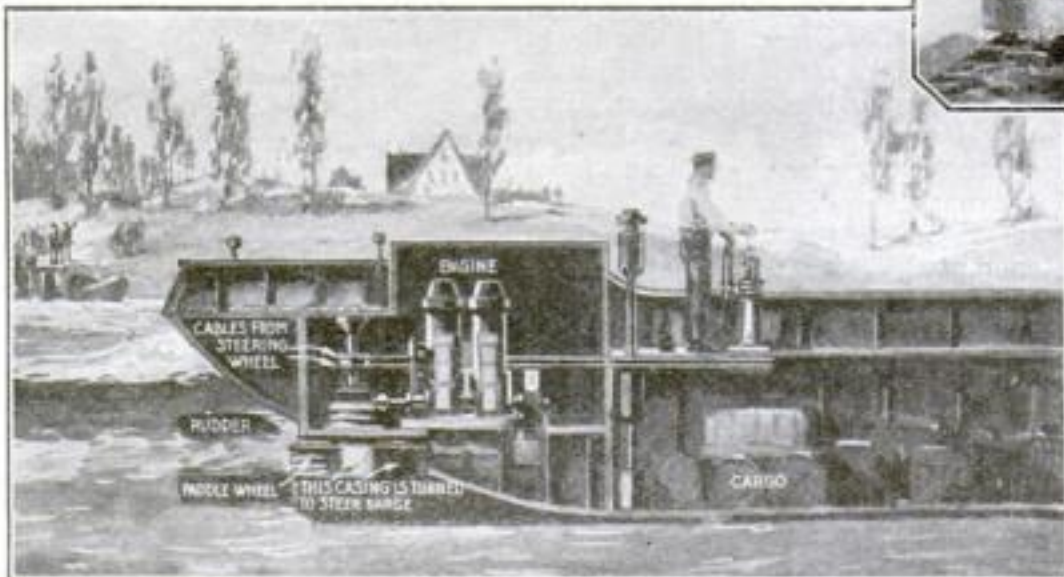
COMpletely submerged, horizontal paddle wheels, so mounted that they can be used as rudders, have recently been introduced by a French company for canal barges and other craft using artificial waterways. In the past, navigation of barge canals has been hindered and their usefulness destroyed by the churning of vertically working turbines and paddles. Mud from the bottom flung to the sides, has narrowed the channels and hindered navigation.

Two of these paddle wheels are located directly under the stern of the barge, the motor chamber being immediately above them. The horizontal action of the paddles, and the fact that they are partially incased in a screen, eliminates churning of the water to a large extent, and so prevents damage to the bottom of the canal.

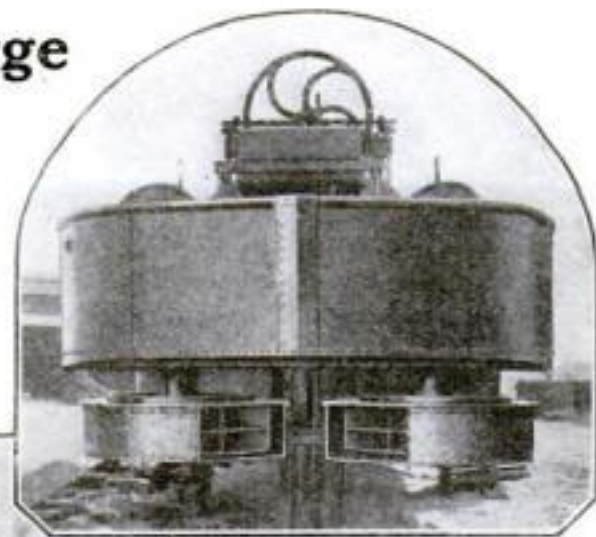
The casing surrounding each wheel is open at the

top, and also has an opening at the side that extends over nearly one quarter of the circumference. Water entering the top opening is pushed out the side opening by the action of the paddle wheel propelling the barge.

Changes in speed and direction are obtained by turning these cased wheels, and consequently changing the position of the

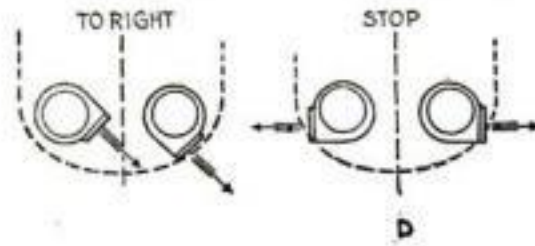
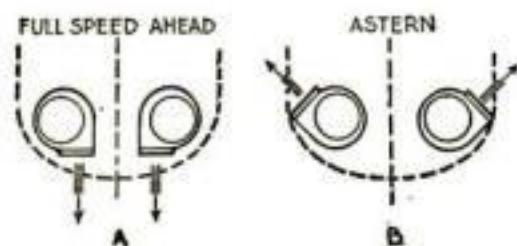


Completely submerged under the stern of the barge, as shown above, the two paddle wheels are used in controlling the movements of the barge. The propellers are incased in flat, cylindrical casings, with openings in the top and sides (see upper photograph). Water entering the top openings is "blown" horizontally through the side openings by the action of the paddles. Thus the position of the side openings governs the speed and direction of the barge, as indicated in the diagrams

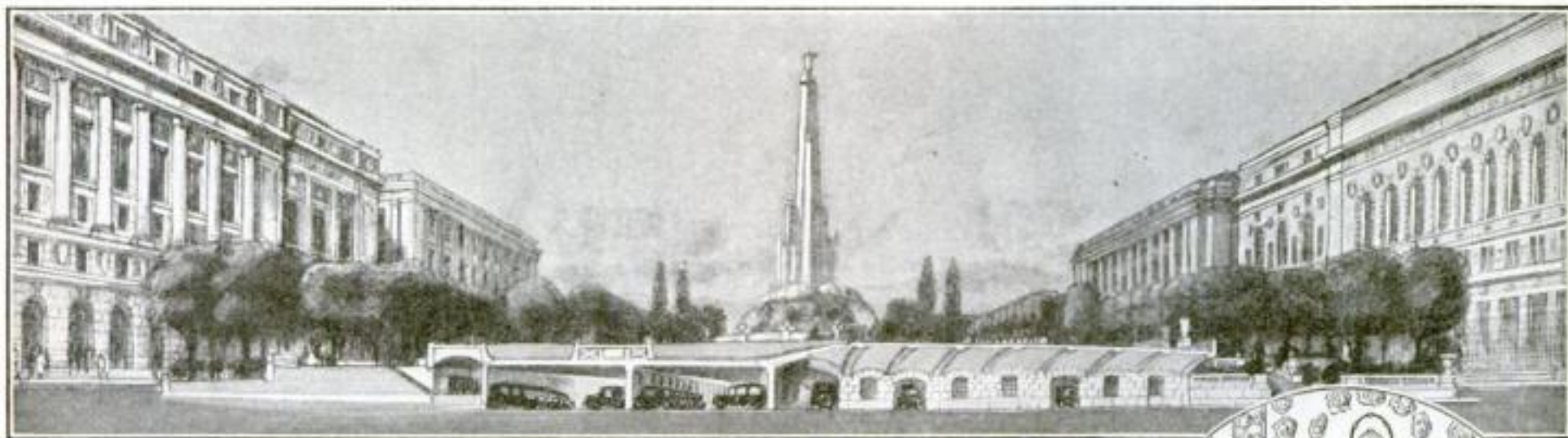


openings. This is accomplished by the engine that drives the paddle wheels, controlled from a platform directly in front of the engine.

It is interesting to note that the first steamboat, the "Charlotte Dundas," designed by William Symington, and successfully operated on the Forth and Clyde Canal in 1802, employed horizontal paddles.



City Plans Underground Parking Space for Autos



How Cleveland plans to build an underground garage and parking space beneath a public park. Entrance to the parking space will be from a depressed street, bridged by the mall

PRESSED by the increasing need for additional parking space for automobiles, the city of Cleveland, Ohio, is planning to install the first underground municipal garage. Cleveland's lead probably will be followed in New York City.

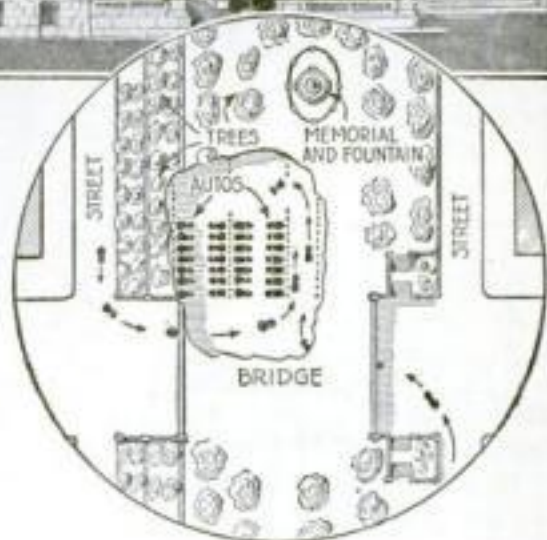
Cleveland possesses an ideal site for underground parking—an expansive mall or open public park, about which is being built a group of great public buildings, all of Roman architecture. Four of these buildings have been completed.

The mall, 1800 feet long and 600 feet wide, running from the post office north to the Lake Erie front will be bridged so as to create underground space for a municipal garage and parking place running the entire length of the mall. The entrance will be

from St. Clair Street, which now runs through the center of the mall. This street will be depressed and bridged by the mall, thus providing an easy entrance to the underground garage.

Initial plans call for sufficient space to accommodate 500 cars. This capacity will be increased if the plan proves successful financially. Law Director Paul Lamb, of Cleveland, who with Francis Swales, of Yonkers, N. Y., devised the plan, estimates that the city should receive a net profit of \$81,000 a year from the 500-car parking space. "It will offer no more mechanical problem than if it were an open parking space," he says. "It will be used exclusively for parking, although there may be a repair shop in connection with it."

Traffic Commissioner John A. Harriss, of



New York City, is considering plans along the same general lines. In the case of New York, Doctor Harriss would utilize space excavated under Central Park to take care of hundreds of automobiles which might otherwise clog the city's traffic.

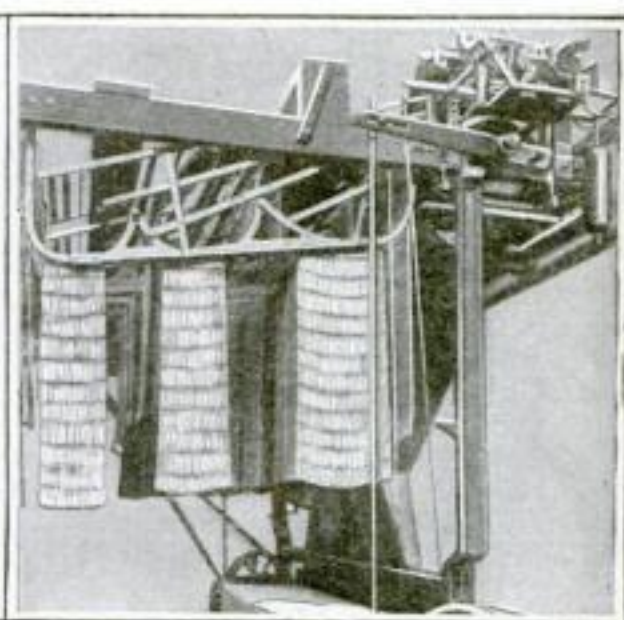
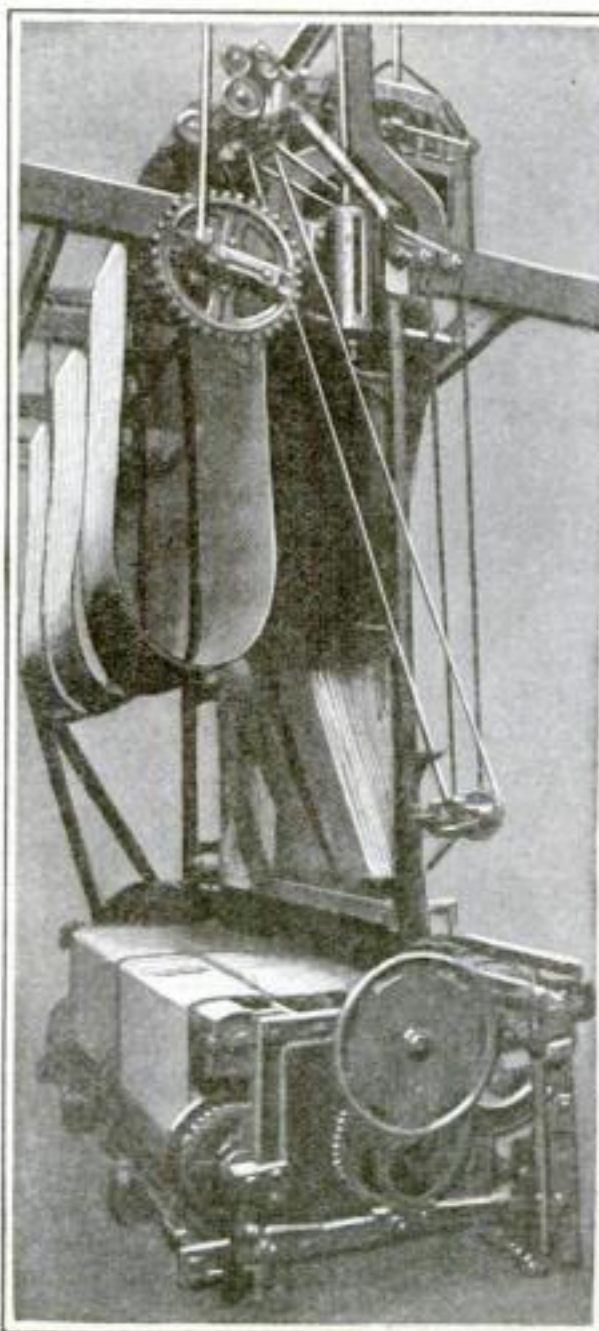
Electric Loom Weaves Elaborate Designs from Metal Photos

ANY home, club or hotel may now own linen and other fabrics of individual design at reasonable cost as the result of an invention by Dr. T. A. B. Carver, of Belfast, Ireland. He has devised an electrical loom that makes use of metal photographs and electrical currents in transferring the artist's original design directly to the automatic weaving mechanism.

Why Linen Is Expensive

Heretofore the weaving of figured linen has been accomplished by the use of ingenious card patterns, punched with numerous holes, each perforation corresponding to one of the thousands of threads to be lifted in the loom. A series of these cards constituting a complete record of the design, is placed on the automatic loom mechanism in such a way as to actuate the lifting of the warp or lengthwise threads, and passing the woof, or crosswise threads, beneath. The cards must be carefully and accurately perforated, and since one series of cards recording a single design may represent a total length of 3000 feet, the process has been tremendously expensive. In some cases the manufacture of a single piece of fabric may entail nine months of labor and a cost of more than \$6000.

The new machine, it is claimed, reduces the time from months to hours and the expense from thousands of dollars to a few dollars. The design is photographed upon a thin aluminum band or record treated chemically so that when it is later immersed in a chemical bath, certain points that are to reproduce the design become electrically conductive. The aluminum



Above: The usual method of transposing a design to the loom by perforated card records. At left: The new way, using chemically treated aluminum bands on which the designs are photographed

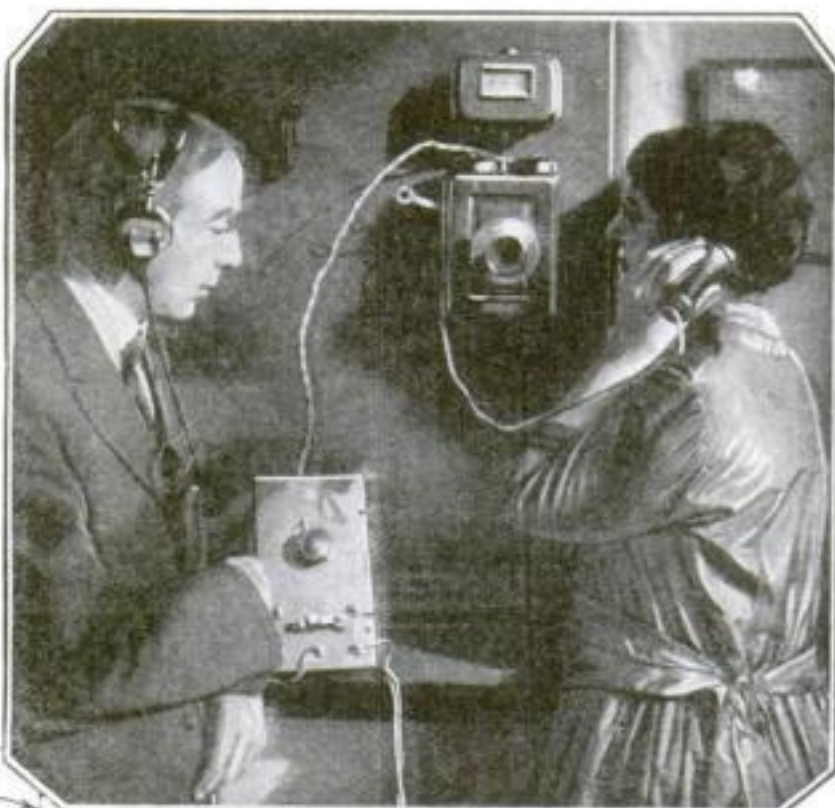
band is then placed on a rotating drum and brought in contact with an electrical apparatus that governs the operation of the loom. By this apparatus, an electrical current passing through the many small conducting points on the metal record completes circuits that actuate electromagnets. These magnets, in turn, attract levers that raise or depress the warp and actuate the throwing of the woof shuttles through the openings thus provided. The non-conducting points of the record break the circuits and release the levers.

Thus, a 12-foot metallic band, which can be manufactured in a few hours, has been used to supersede 3000 feet of cards!

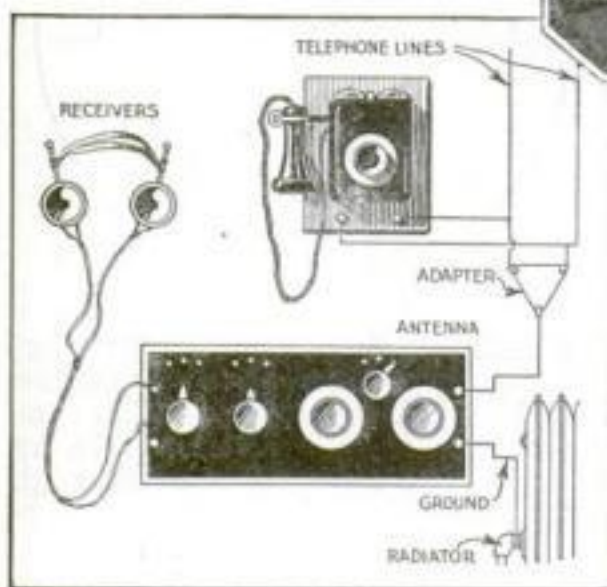
Phone Wire Aerials for Radio Service

THE practicability of general public use of telephone wires as radio aerials is being demonstrated in the state of Washington, where the Seattle Radio Association—a broadcasting enterprise—and the Puget Sound Telephone Company have entered an agreement by which any telephone subscriber, using a newly invented adapter, may convert phone lines into an aerial for his receiving set. This arrangement is especially valuable for radio fans who are unable to erect aerials because of unfavorable locations or landlords' restrictions.

The agreement provides that the radio association will supply



Hooked up with the wired telephone lines and with the antenna post of the radio receiving set, as shown in wiring diagram at left, the adapter converts the telephone wires into a wireless aerial without interfering with telephone conversations



Car Rails Welded and Laid in Long Sections

BY WELDING together several lengths of rail and laying the long sections so formed, a street railway company of Washington, D. C., found it possible to replace tracks on an entire line without interrupting traffic.

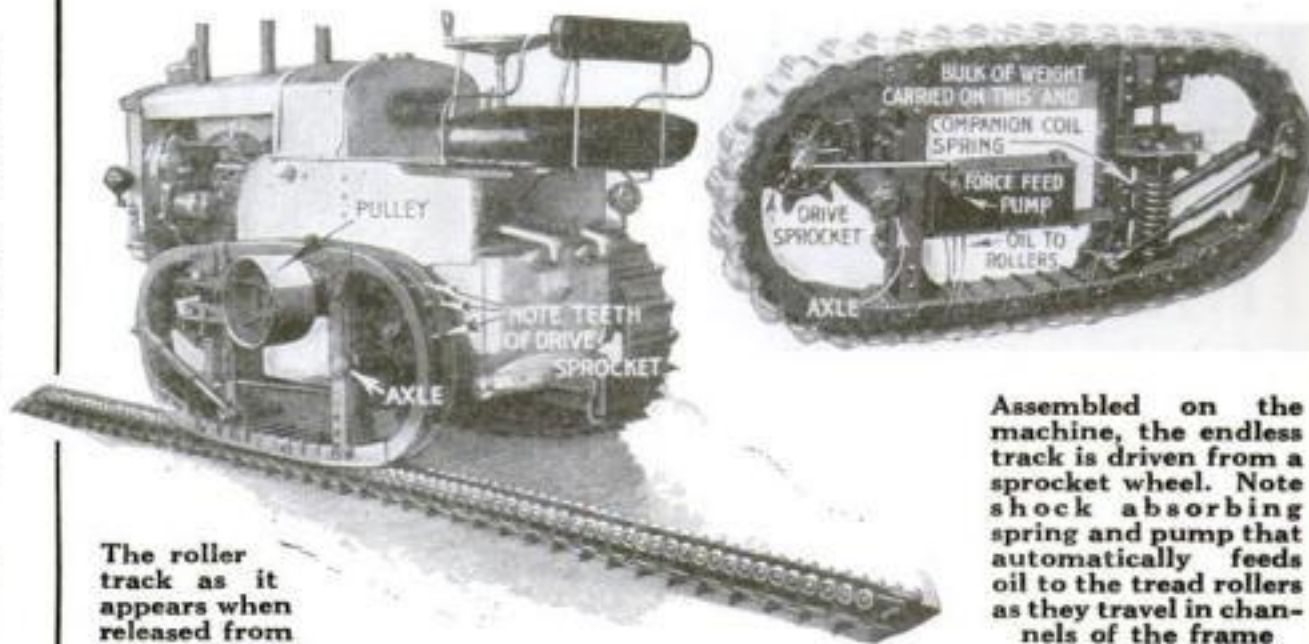
The work of welding the rail lengths was accomplished during the daytime when traffic was heavy. The completed sections were placed at the edge of the track and installed during the early hours of the morning.

In one case a pair of rail sections, each consisting of seven rails, and with a total length of 420 feet, was so installed.



Seven rails, welded together into one, are laid at one time

Endless Tread Runs on Steel Rollers



The roller track as it appears when released from channel frame

A NEW "track laying" tractor, the entire weight of which travels on anti-friction rollers, has been designed to minimize wear and "knocks." Advantages claimed are: that it covers a wide range of duty without change of cleats; that its self-cleaning cleats do not fill with earth; that it increases the amount of motive power delivered to the drawbar, and that it makes shorter turning possible.

The tractor treads travel around a channel framework on a double endless chain of hardened steel rollers. The treads are so constructed that each part is replaceable. They are driven from an eight-tooth sprocket located on the

Knocks Sun from Windows

MERCHANTS can overcome dazzling and objectionable sunlight reflections in plate glass show windows by lighting important objects in the window display with high power spotlights, according to statements made at a recent convention of the Illuminating Engineering Society.

countershaft, all other wheels and gearing being dispensed with.

Lubrication of the track roller, effected by a force feed pump driven from the hub of the countershaft, is automatic because the pump will run only when the track is in operation. Most of the weight of the machine is carried on coil springs that can be tightened at will to meet conditions.

Protruding from the left side of the tractor frame is a driving pulley for belt work. This pulley receives its power through the same friction clutch in the flywheel that transmits the power to the tracks.



The new adapter, showing binding posts for connections with telephone wires and with radio receiving set

dollars a year to the telephone company, 50 per cent of which goes to the telephone company for its services in forwarding the programs and installing the device and 50 per cent to the association for providing the broadcasting programs.

The adapter, modeled somewhat along the lines of the aerial condenser plug, consists of an arrangement of condensers the outer plates of which are connected with the telephone lines and the inner plates with the antenna post of the receiving set.

The First Successful Color Movie

How an Inventor, by Ingeniously Combining Blue-Green and Red-Orange on Double Photograph, Tricks Our Eyes into Seeing Delicate Shades of All Colors, Vividly Representing Life

WHEN I was told, a few weeks ago, that another new process for taking motion pictures in color had been "perfected," I confess I smiled skeptically to myself.

I had seen many colored movies before. They had left me either unimpressed or thoroughly displeased.

To be sure, I knew that this new method had been invented by a scientist of distinction—Dr. Daniel Frost Comstock, of Boston—and that 10 years of patient research and experiment had gone into its development. I was told that more than \$1,000,000 had been spent upon these experiments; that the enterprise had the financial backing of no less a figure than William Travers Jerome, former District Attorney of New York, and that artists and motion picture experts who had seen the film hailed it as a phenomenal improvement, charming in its colorful realism, lessening eyestrain, and destined to revolutionize motion picture work.

A Colorful Dream Comes True

And, finally, I had fully shared the great dream of motion picture enthusiasts during the past decade—the dream that the movies some day would be shown to us in all the beauty of natural color, enhancing enormously the power of their appeal.

Nevertheless, I did not realize the art had advanced far enough to make this dream a reality. But when I witnessed the private exhibition in New York of this new colored film feature—a play called "The Toll of the Sea," starring the young Chinese girl, Anna May Wong, whose fame has begun to spread eastward from Cali-

By Thomas Elway

fornia—I was frankly surprised by the unexpectedly high quality of the color work. Here was a film in which colorful costumes and feminine beauty moved convincingly across the screen, with slight trace of the garishness, flicker, and distracting color fringes that have hurt so many other color films.

Not that this color work is perfect. Some of the reproductions of blues and greens are bad. The yellows are even less satisfying. But this motion picture does constitute, to my mind, the best color work done so far in the films, and the process used, the new Technicolor process, promises still better things to come. For the first time I have begun to expect something really big from color photography on the screen, something that will affect the fundamentals of motion picture art. It isn't only that we may expect enhanced charm of settings, and still greater beauty of feature in our heroines; or that we shall see them blush real blushes, as we now see them weep real tears; that expressions will be more lifelike, costumes more fascinating, natural scenery more magnificent.

A successful color movie can do something much more fundamental than this. It can give us not merely an improved art, but a new art; a new kind of dramatic production, differing from the present productions in black and white as completely, perhaps, as these differ from the productions of the spoken stage.

How can this be? Because color alone,

pure color, has a powerful appeal to the human mind. This is always the great aim of drama—to seize on the emotions, to contrive that you are completely "carried away" by the thrill, sentiment, joy or sorrow of the play.

There is no doubt that color has this appeal. Red excites and stimulates us;



The New Color Film and Its Inventor

HERE is an exact-size reproduction of a section of the new color motion picture feature film, "The Toll of the Sea," starring the young Chinese actress, Anna May Wong. This lifelike movie made possible by the remarkable color process invented by Dr. Daniel Frost Comstock (inset), is called by the artist, Maxfield Parrish, "highly successful from a color point of view and an invention with endless possibilities—a revolution in the moving picture art"



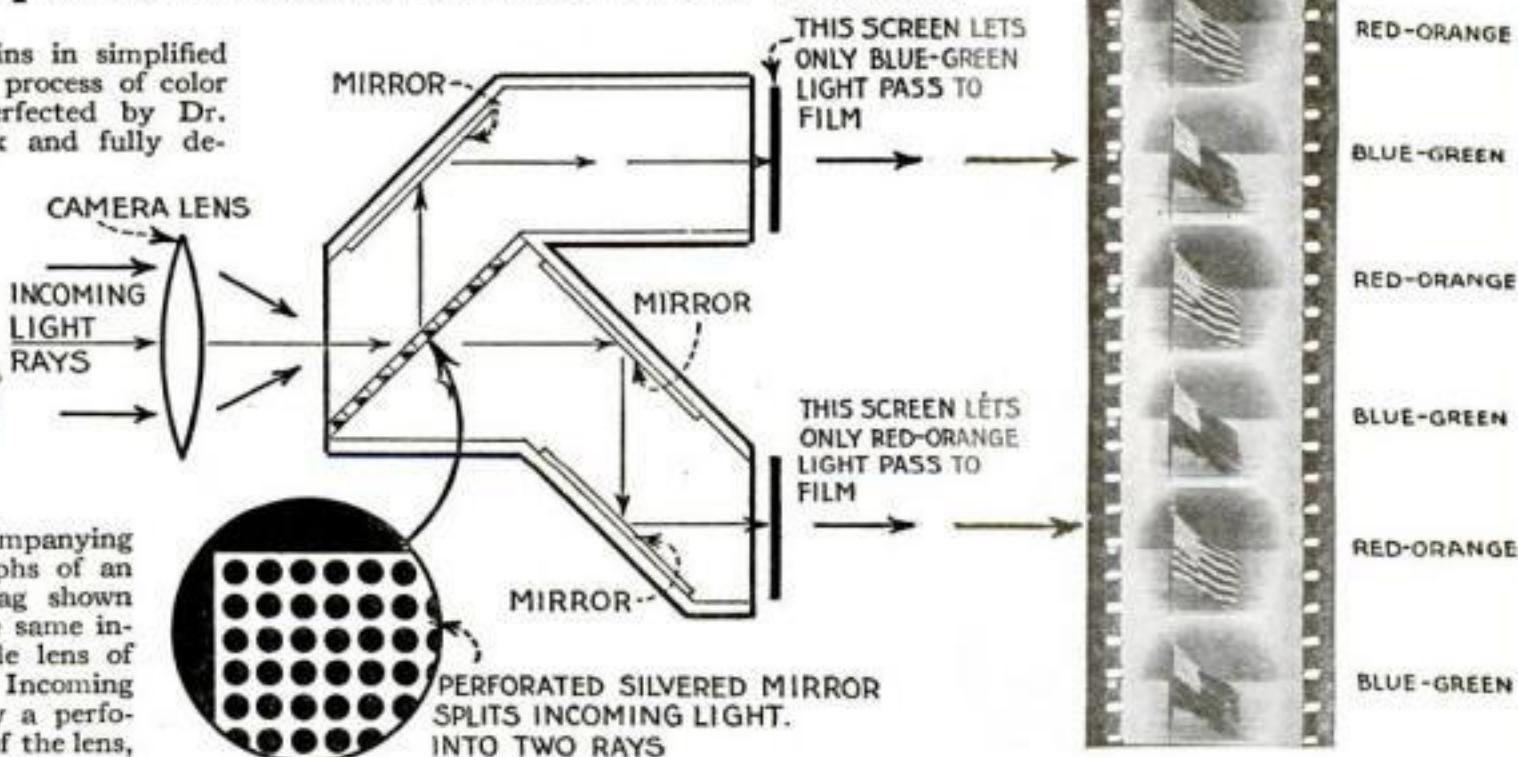
Light Rays Split and Filtered in New Color Camera

THIS diagram explains in simplified form the ingenious process of color movie photography perfected by Dr. Daniel Frost Comstock and fully de-



scribed in the accompanying article. Two photographs of an object, such as the flag shown above, are taken at the same instant through the single lens of the movie camera. Incoming light is split in half by a perforated mirror just back of the lens, one half being led through a color filter that allows only blue-green light to reach the film negative, the other half led through a second color filter that allows only red-orange light to pass to the film.

Thus the film negative of the flag, shown at the right (slightly reduced),



consists of a succession of double images, alternating blue-green and red-orange impressions, but still in black and white. In the positive print of this negative, the blue-green and red-orange images are superimposed, one on the front, the other on the back of the positive film. The positive film then

is dyed, the blue-green images taking blue-green dye and the red-orange images red-orange dye.

When projected on the screen, the film gives the effect of reproducing all the original colors of the flag in their natural shades.

George Fitzmaurice, Movie Producer, Says:



"AS TO whether color photography will enhance the dramatic quality and realism of the picture—that is rather hard to tell. I cannot see where natural color will detract from the drama so long as the color remains neutral and unobtrusive. "Still, I think that the great progressive step will be taken when stereoscope photography has been fully developed. And the millennium will come when stereoscopy and color combine to produce the perfect whole."

Rupert Hughes, Motion Picture Writer, Says:



"IT SEEMS to me that color processes in motion pictures will probably follow the same line as in book and magazine illustration: for certain special effects they will furnish great charm, richness, and contrast, but for general use the single-tone pictures will enormously prevail. It would be ridiculous to deny the beautiful possibilities of occasional color, though I cannot believe that it will ever drive the monochrome, or one color, process off the screen."

green is restful and sedative. To play on people's minds with color as we now play on them with moving images or written words, will require, of course, a completely new kind of directing. There will be new lighting, new make-up, a new technique of screen acting.

But first there is a scientific problem—Can it be done? Is the color movie an accomplished fact?

As yet we cannot say that it is. But we can say that it promises to be. The new process we are discussing is a long step toward the fulfilment of this promise.

A College Professor's Vision

This process is a professor's dream come true. Ten years ago, Dr. Daniel Frost Comstock was a professor of physics in the Massachusetts Institute of Technology. He knew a good deal about color photography. He dreamed of applying it to motion pictures. With Mr. Herbert T. Kalmus, his partner in an engineering firm, he went to work. They began experiments. They organized the Technicolor Company and gathered a group of able scientists and engineers.

For years the experiments failed. Finally, success began to come. One by one the worst of the technical difficulties were

overcome: the difficulty of taking two pictures at once through the same lens; the difficulty of finding the two dyes that were exactly the right ones to use in coloring the film after it had been photographed; the many difficulties that came from the extreme weakness of the light after it had passed through the complicated system of lenses and prisms required for the color camera. Film shrinkage, too, was overcome and the many other obstacles that stood in the way of making the two differently colored images fit exactly one on top of the other when they came to be printed on the same strip of film.

Probably you have heard color photographs described as "two-color" or "three-color." Doctor Comstock's films use only two colors to produce the effect of six. To understand what this means, we must recall a few facts about the nature of color and about color vision.

Ordinary white light like sunlight is made up, you remember, of six primary colors: red, orange, yellow, green, blue, and violet. You can prove this by putting a glass prism into a beam of sunlight, and noting how it splits the white light into a strip of these colors, a spectrum. You see them in a rainbow.

White light is believed to be made up of waves or vibrations of various lengths,

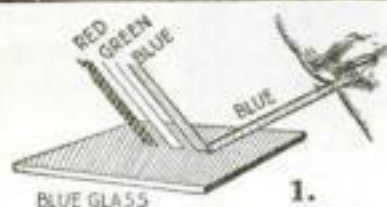
each wave length producing a distinct color sensation. Red light from a red glass lamp globe looks red because the waves producing the other five color sensations are held back by the red glass. The orange, yellow, green, blue, and violet waves are absorbed. Only the red waves get through. Similarly a blue globe lets through only blue light, and so on. A red paint or dye is merely a substance that reflects only red light, absorbing all the others. A yellow paint reflects only yellow light, etc. These are the physical fundamentals of colors.

How Our Eyes Mix Colors

But this color theory is partial. It leaves out the human eye. You look, for instance, at an apple. Something happens in your eye. You have a sensation of redness, an impression that the apple is sending red light into your eye.

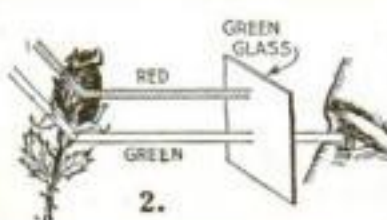
This seems straightforward enough. The eye, you say, must contain some mechanism able to perceive red light as such, able to sort out the light of the six different primary colors and recognize each for what it is; to recognize each color by itself. What could be simpler?

It is simple, true enough, but it is not what happens. Make an experiment. Take

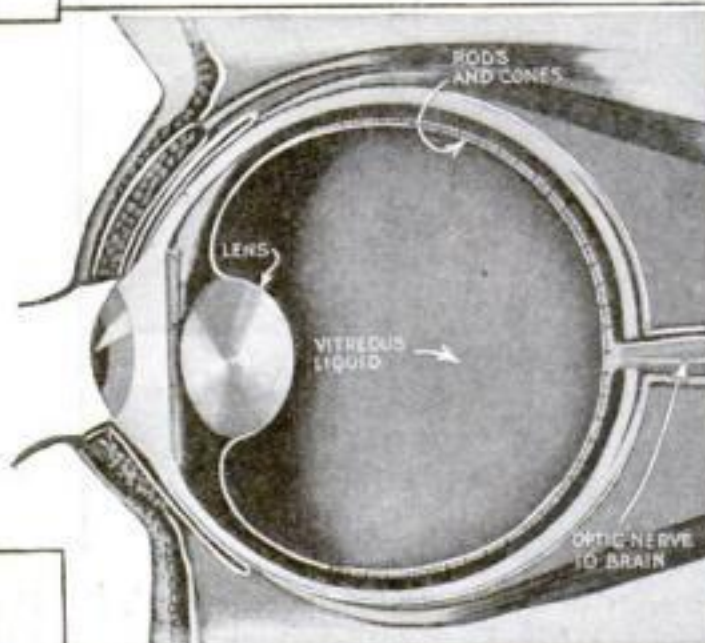


Sunlight contains rays causing all color sensations. Light from a blue glass looks blue to us because the blue glass absorbs all the light rays except the blue rays that it reflects to our eyes.

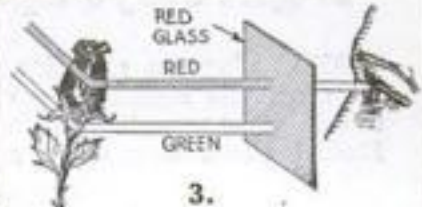
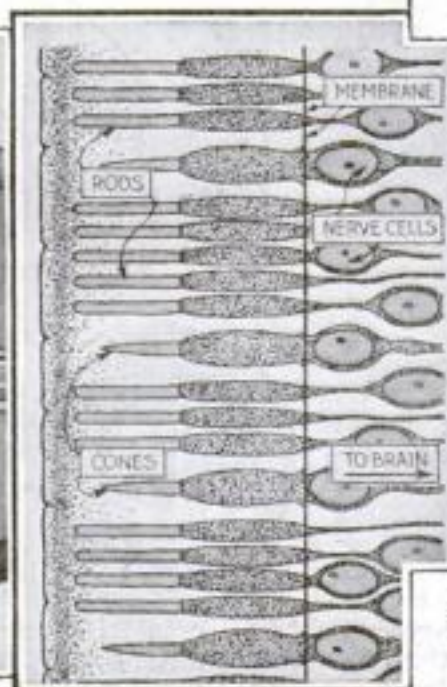
Below: A green glass absorbs the red rays from the rose, but allows the green rays from the stem to reach the eye.



Facts Explaining How We See Color and How Color Screens Work



Scientists believe we detect colors through minute, sensitive nerve endings, called "rods" and "cones," in the membrane of the retina behind the eyeball. These nerve endings (shown in highly enlarged cross section at upper right) transmit light stimuli to the brain.



Above: A red glass absorbs the green light waves, allowing only the waves that produce the red sensation to reach our eyes from the rose.

Below: Analyzed in front of a spectroscope, a mixture of yellow and blue paint is found to produce yellow light and blue light; yet our eyes, in blending these lights seem to see green.



Marcus Loew, Owner of 75 Theaters, Says:

"I RECENTLY witnessed a showing of a colored moving picture of the Chinese story called, 'The Toll of the Sea,' which was shown by Judge William Travers Jerome. I thoroughly enjoyed the picture and consider the process highly successful.

"The picture was made far more effective and convincing by the soft, wonderful coloring.



Charles Dana Gibson, Artist-Illustrator, Says:

"I HAVE seen all the color processes so far, and the new process represented in the picture, 'The Toll of the Sea,' is far and away the best. The effect is convincing and most restful to the eyes and altogether irresistible.

"I am looking forward to seeing the picture again.

"It is my belief that this new process will revolutionize the motion picture industry."



some yellow paint and some blue paint and mix them. What do you get? You get green paint.

This fact is so familiar that we are apt to forget how startling it is. Think for a moment of what it really means. There are six primary colors. These are separate physical things—different kinds of light. You mix two of them, yellow and blue. You do not get a mere mixture, a yellowish blue or a bluish yellow. You get a third primary color, totally different from the yellow and blue, another one of the original six!

What is the explanation? Simply this: The mix-up is in the human eye. The eye does not perceive the six primary colors separately and individually. It confuses and blends them in a very complicated way.

Green Isn't Green

Take, for instance, our mixture of yellow and blue paint. Put this in front of a spectroscope, and analyze the light from it. You get yellow light and blue light—no green light at all. Physically, the mixture of paint reflects just the lights that the two separate paints did. The blending of these lights to make green is done, somehow, in the eye. The eye is fooled. It really sees blue plus yellow. It thinks it sees green.

There are innumerable other ways to fool the eye on colors. For instance, mixed red and green (of the proper tints) look white. Certain yellows and certain violets, when mixed, also look white. The eye is simply unable to distinguish between a red-green mixture that looks white, a violet-yellow mixture that looks white, and a true white containing all six spectrum colors.

The theory for all this is very uncertain. In the membrane that lines the back of the eyeball—the retina—there are two kinds of minute nerve endings—the rods and the cones. It is supposed that we detect colors through the sensitiveness of these nerve endings to different light vibrations. It used to be believed that the rods saw red and green and the cones saw blue and yellow. This was disproved. Then it was

believed that the cones saw all colors, while the rods saw only light intensity, that is, differences between light and dark. Now even this is doubtful. The plain fact is that we don't know how we see. We know only that the mechanism is extremely complicated, that color vision is especially so, and that, somehow or other, the nerve endings in the retina are variously stimulated by various wave lengths of light, and

to represent all colors. A mixed red and green, you remember, will look like white. We are going to extend this. We are going to choose two colors, make various mixtures of these two colors and fool the eye, if possible, into thinking that it recognizes in these mixtures all of the six primary colors.

The best proof that this can be done is that it has been done. As you view a two-color film like "The Toll of the Sea," you think you see all the colors. With a few exceptions to be noted later, the eye is fooled successfully enough.

Two-Color Dyes

In this particular feature, as in most other color movie processes, the two colors selected are a reddish orange and a bluish green. These colors are represented by two dyes, carefully chosen from more than 200 dyes that were tried. As I shall explain later, the original photograph consists of two separate images. One image, printed on one side of the film used in projection, is dyed blue-green; the other, printed on the reverse of the film, is dyed red-orange. Where the images overlap, these dyes blend. In projection onto a screen the light is colored by the dyed images, the colors blend likewise, we see both images together, and the eye does the rest.

What we really see are various shades and mixtures of blue-green and red-orange. What we think we see are all the colors of the spectrum. It all depends upon the capacity of the eye for being wrong

about colors. It is just like the rabbit that you think you see coming out of the conjurer's hat.

This is what the two-color photograph is, but how is it taken? In exactly the same way. You take two photographs at the same time, one through a screen that lets pass only the blue-green color, absorbing all others; the second through a screen that absorbs all but the red-orange. Suppose you are photographing a red and blue dress. The red parts "take" only on the

(Continued on page 114)



How Constance Talmadge Would Make Up for Color Movies

ON THE right side of this popular star's portrait are indicated the points in her make-up for black-and-white movies. See how entirely different is the make-up she will be likely to use in color movies, indicated on the left side of the picture. This probable make-up is based on results of recent experiment

transmit the stimulus to the brain, where the consequent perception of varying colors is produced.

But perhaps you are asking what all this has to do with color movies. It has everything to do with them. Color movies are possible at all only because we are able to fool the eye about colors.

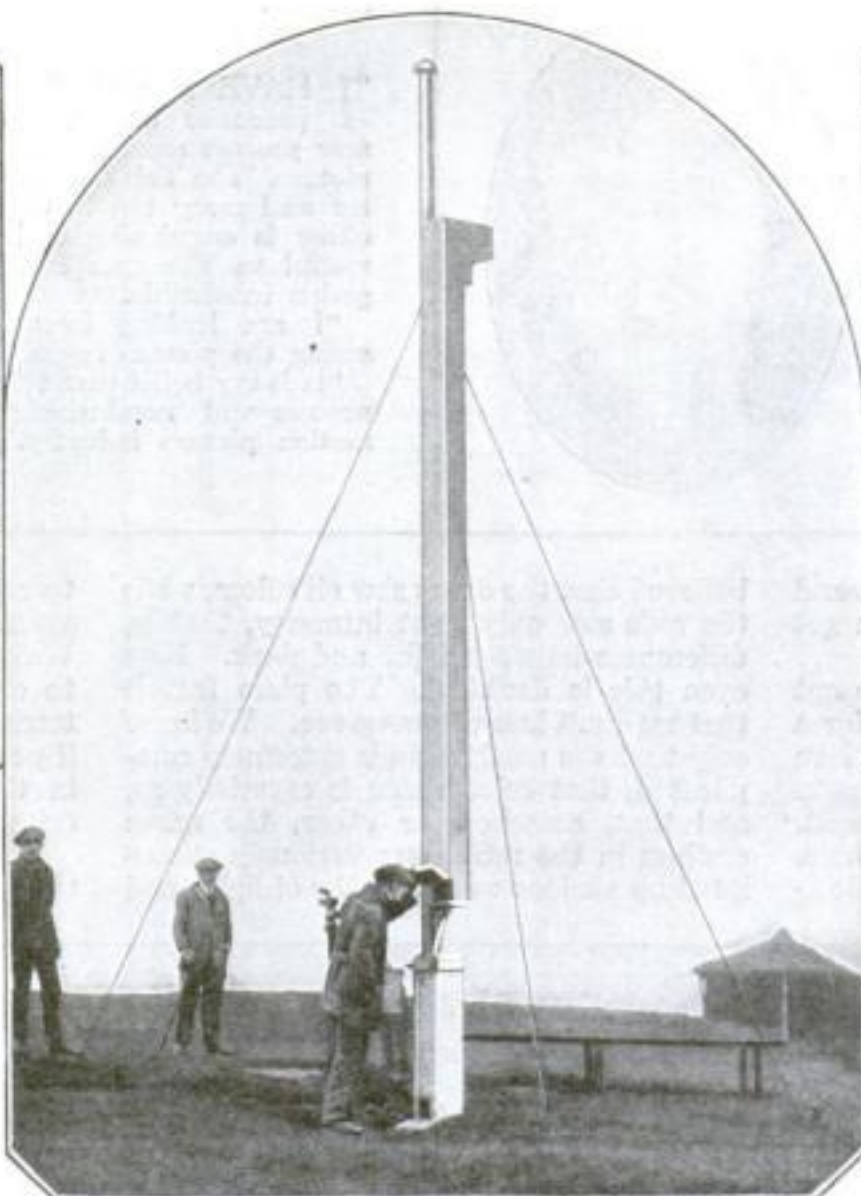
The new Technicolor process, for instance, is a "two-color" process. This means merely that we dye the films with two colors only, but by mixing them in different proportions we are going to try

Novelties of the Moment Told in Photographs

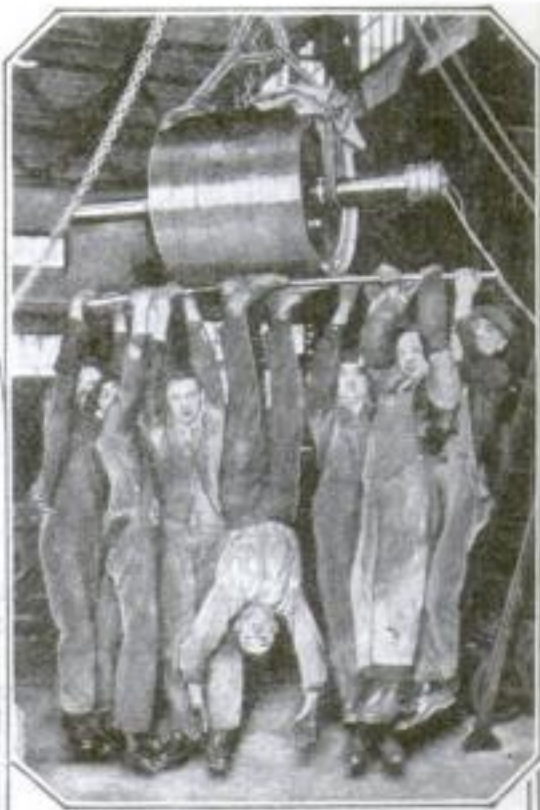


Skating across U. S.

Earning their way by "stunt" performances in towns through which they pass, this happy-go-lucky couple, Mr. and Mrs. Fred Carson, of Philadelphia, Pa., are roller skating across the United States and back. They started from Philadelphia in May, 1921, and nobody knows when they will finish. Their route is to Seattle, Wash., then south to San Diego, and home again through the Southern states

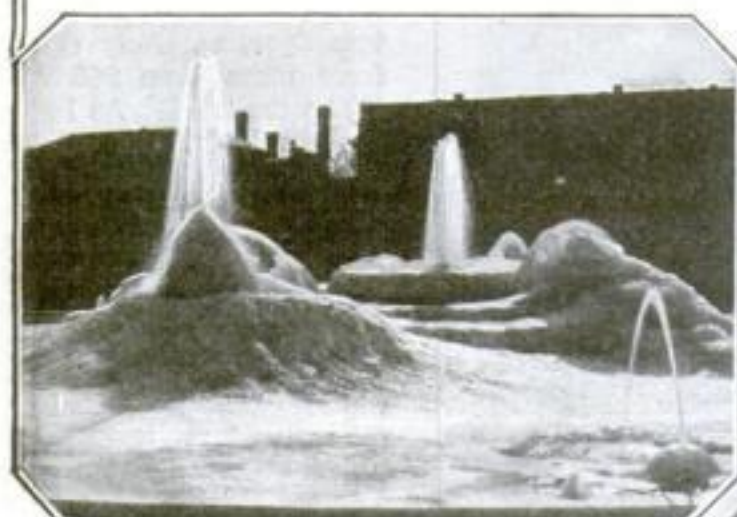


At a "blind" hole, the periscope is now solving a difficult problem for the golfer who can't see the flag on the next green. By peering into this 20-foot tube, he can find out whether "all's clear"



Hanging by His Soles

Demonstrating the remarkable strength of a magnetic pulley, six of these men, whose combined weight is about 1000 pounds, hung from an iron bar in contact with the pulley. For the seventh man, hanging head downward, the only support was the attraction of the pulley for the iron nails in his shoes! The pulley was magnetized to attract small particles of iron from heavy loads of conveyed material

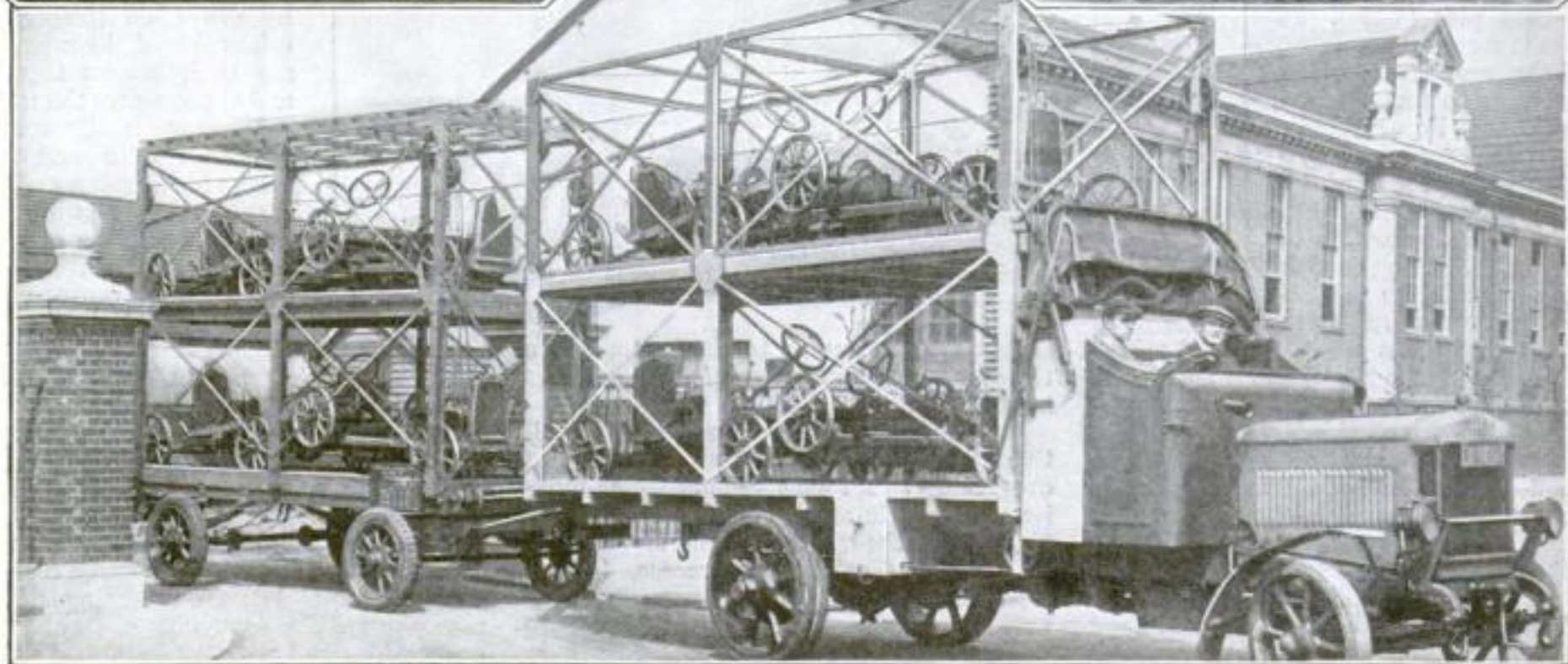


Icebergs in City Park

Perpetual fountains in Logan Square, Philadelphia, convert the square into a sparkling iceberg in winter, as shown at the left

Cycling on Water

The five-passenger "bike" (at right) travels on land or water. In the water the front wheel acts as a rudder. The rear wheels operate paddles



How a British automobile manufacturer delivers eight auto chassis to the body builders in one haul. Four of the chassis are carried on a two-story steel framework structure on the truck, the remaining four on a trailer

This Alarm Clock Jogs the Busy Man's Memory

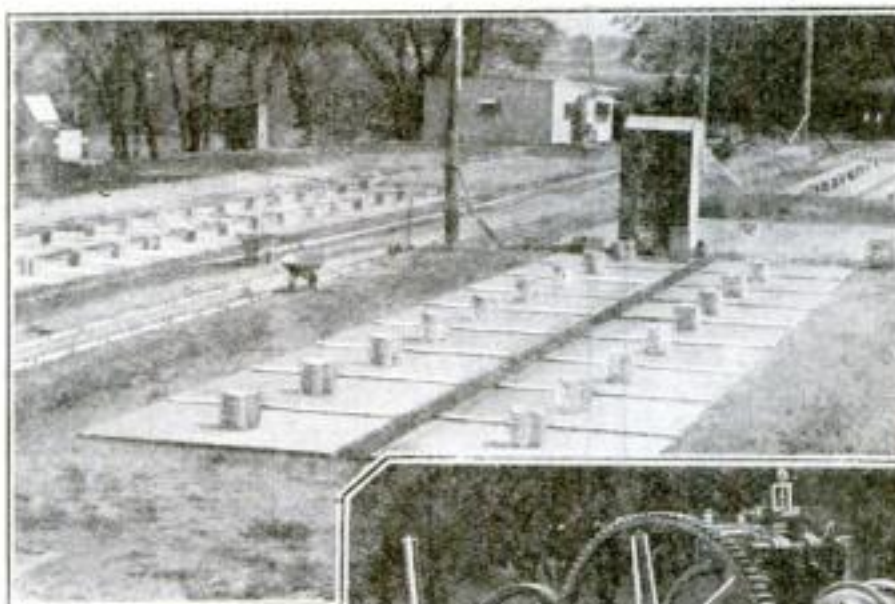
SERVING as a memory jogger for the business man, a reminder clock, recently perfected, rings an alarm when the hour for an appointment arrives.

The rim of the dial has 48 slots into which small cards can be inserted. Each of these slots with card inserted, controls the alarms for a quarter-hour interval. Thus, should a reminder be required for 3.15, the card is inserted in the first slot between three and four. At that time, the alarm will ring for eight minutes, or until the card is removed.

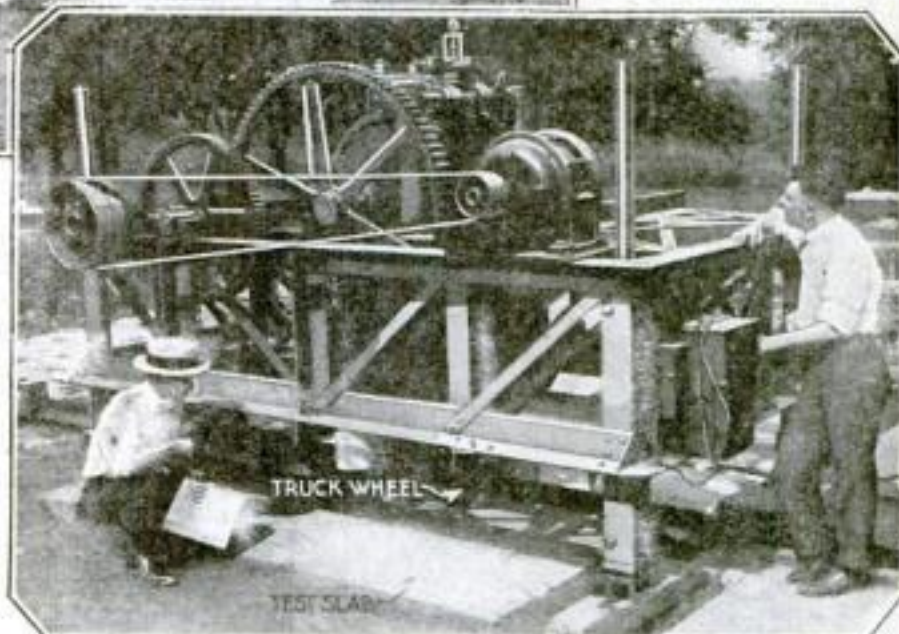
As a further reminder of the purpose of the call, notations may be made on the card. Such notations would permit several persons to use the clock.



Road Tester Drops Heavy Truck Wheels



Effects of the impact of a truck wheel raised and dropped on concrete slabs by the electrical road testing machine shown below are registered on recording devices. For a further test, cylindrical concrete blocks, cured with the slabs as shown at left, are compressed to destruction.



BY REPEATEDLY dropping a typical truck wheel to the pavement from any desired height, a new portable electric road-impact machine, now used by the United States Department of Agriculture to test concrete slabs, subjects the concrete in a few hours to wear and tear as great as that produced by driving a truck over a pavement for months.

The truck wheel is alternately raised and dropped by means of an electrically driven cam. Recording devices measure the rate at which the wheel is brought to rest after

contact with the slab, deflection of the slab at a number of points on a line across it, settlement of the slab into the subgrade, the permanent set of the slab, and the maximum fiber stress at the point at which the blow is struck.

Small cylindrical blocks, made of the same concrete and cured on the slab, are used to determine the compressive qualities of the slab. These blocks are placed in a machine when cured, and are then compressed to destruction.

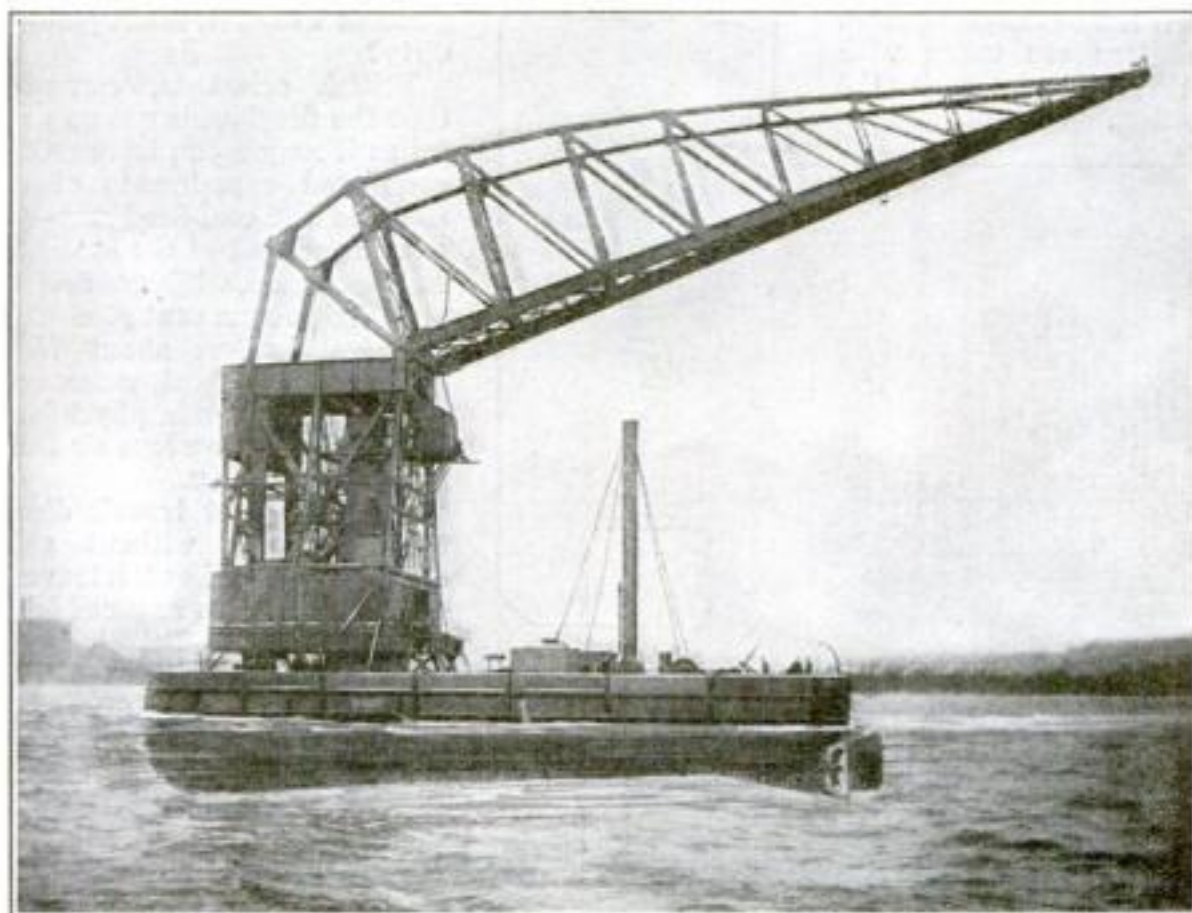
Giant Floating Crane Propels Itself

A MAMMOTH self-propelled floating crane, capable of lifting loads of 150 tons, is the recent contribution to the list of giant engineering equipments, by a Dutch engineer and shipbuilder, Mr. Werf Gusto.

The crane, of the derrick type, is provided with two sets of tackle, from each of which loads can be deposited upon

the deck of the hull on which the crane is supported. Traveling counterweights serve to keep the pontoon level when loads are being lifted.

A boiler located in the hold provides the power for propelling the craft as well as the generator that supplies power for the electric crane. The crane can be operated by one man.



The huge floating crane, showing hull and propeller



Motor Driven Rolling Pins Massage Body

AN ELECTRIC massage apparatus that enables the operator to massage the entire body of a patient in a few minutes consists of a series of eccentrically mounted rollers on a shaft driven by means of a chain from an electric motor.

The rotating of the shaft causes the eccentric rollers to knead the body over an area equal in width to the length of the shaft, or about 1½ feet.

THE Editor will be glad to supply, wherever possible, the names and addresses of manufacturers of devices mentioned in this issue.

New Oxygen Mask Designed for Rescue at Sea

FURTHER development of the gas mask has resulted in a new breathing apparatus for rescue work, recently perfected for the navy by the United States Bureau of Mines.

The mask enables the wearer to remain under water for 15 minutes. It consists of a rubber breathing bag in which oxygen, escaping from a tank, is mixed with air from the outside. This air enters the bag through a canister or absorption cartridge which purifies it. Air discharged from the lungs escapes without entering the breathing bag.

The apparatus will find ready use in mines and at fires.



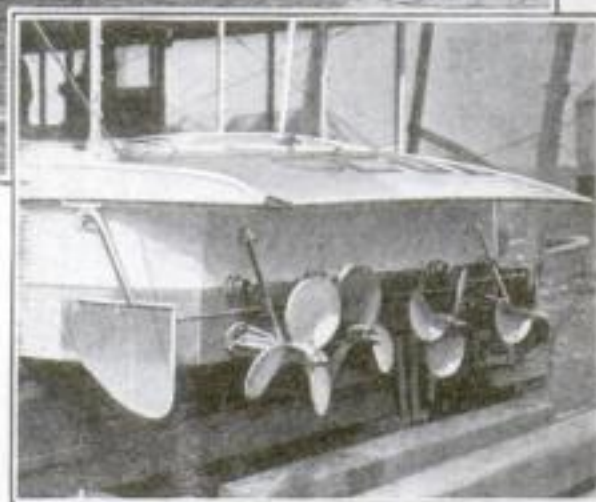
In the breathing bag oxygen and outside air are mixed

Sea Sled Driven by Surface Propellers



Carrying a load of 51 passengers, this novel sea sled designed for shallow water transportation, recently skimmed over the Connecticut River at a speed of 30 miles an hour

At right: Drydock view of the stern showing four surface propellers and side plate rudders designed to eliminate water resistance



DRIVEN by four surface propellers, and designed to skim over the top of the water, a sea sled, built for use as a passenger boat on the Magdalena River, Colombia, S. A., recently developed a speed of 30 miles an hour carrying a load of 51 passengers up the Connecticut River.

The unusual craft is especially designed to operate in shallow waters. Its hull is shaped like an inverted V so that it glides over the surface of the water instead of plowing through it, this feature resulting in comparatively small loss of power from water resistance.

Since the propellers are at the surface, dragging of shafts and struts through the water, with consequent loss of power, is eliminated. In addition, there is little danger that the propellers will encounter the weeds of shallow waters.

Rudder at Each Side

Side plate rudders also offer little resistance to the speed of the boat, since they form a prolongation of the sides. They are so designed as not to be loosed or damaged by weeds or submerged obstructions.

Skew Arch Tested to Destruction

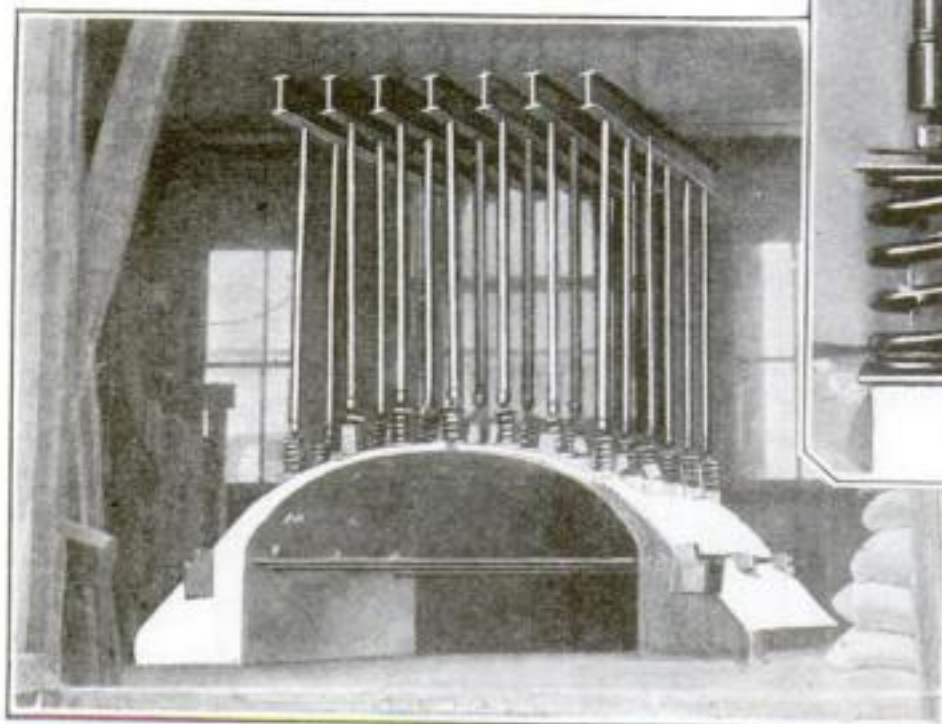
WHILE it has been comparatively simple for engineers to design economically an arched bridge to cross a stream at right angles, there has been considerable difference of opinion regarding the correct design of a skew-arch bridge (one that crosses a stream or road diagonally).

To obtain figures for such a design, engineers of the United States Bureau of Agriculture have constructed a skew arch one fourth the size of an actual bridge. This they are testing to destruction by increasing the load upon the top of the arch until it collapses.

The load is applied by downward pressure on spiral springs distributed over the top of the arch capable of carrying a load of 1500 pounds. Pressure is obtained by tightening screws located between the springs and vertical pipes braced against

crossbeams above. The pressure on each spring is determined by measuring the distance it has been compressed.

Readings are taken with a strain gage to determine the distortion.



Distortion of parts of the arch under increasing pressure, exerted on springs above the arch, is measured by strain gages. Inset shows one of the springs with indicator to measure pressure



British Experimenters Defend Fireplaces

HAVE we been right in discarding the picturesque open fireplace as wasteful, inadequate and dirty?

British scientists, contending that the fireplace is not so wasteful as it may seem, have recently completed experiments showing that the best coal-fired grates give out 25 per cent of the heat of the fuel consumed, while gas fireplaces are nearly 50 per cent efficient and electrical heaters about 75 per cent. Radiant heat, moreover, is said to have certain physiological advantages over warm air from a heating apparatus.

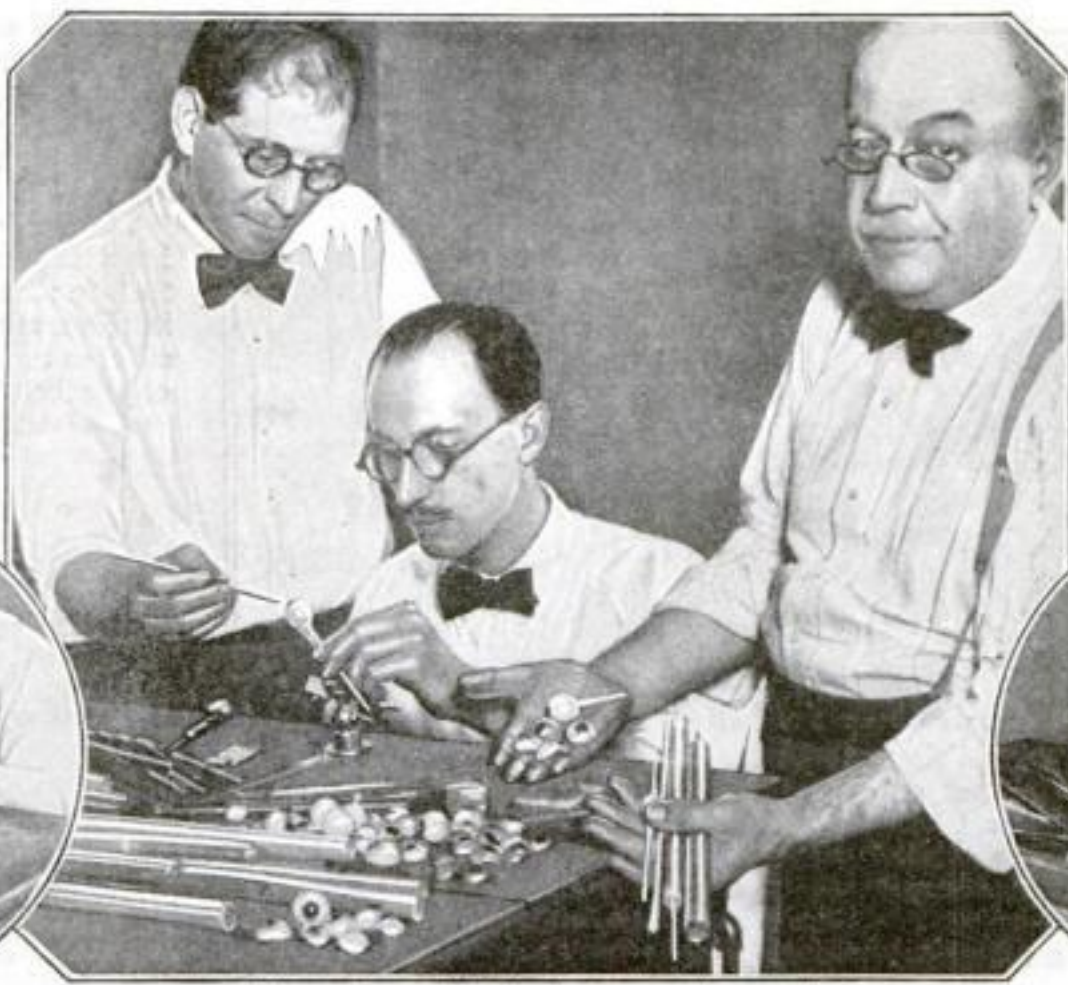
Radiated heat travels directly through space without appreciably warming the air it traverses, although it heats any solid body it strikes. The British heating

idea was explained by Prof. W. A. Bone, of the British Fuel Economy Committee:

"The more nearly conditions under which our living rooms are warmed and ventilated approach those of a warm summer's day—a cooling breeze blowing around our heads, the varying sunshine warming one side of the body, and the heated ground warming our feet—the more healthful our rooms will be; radiated heat creates these conditions."

Lifelike Glass Eyes that Pass for Real Ones

ONE person in every 300 wears a glass eye! When you consider that you may pass hundreds, or even thousands of persons a day, without observing one case of sightlessness, this astonishing estimate, coming as it does from reliable manufacturers, is convincing evidence of the



blown and shaped to form an eyeball, the iris and pupil are "painted" by fusing colored glass pigment.

First the artist heats one end of the tube over a blowtorch, and draws this end out to a long, narrow tube, which serves as an operating "handle." Next, he melts off a portion of the half-inch tube,



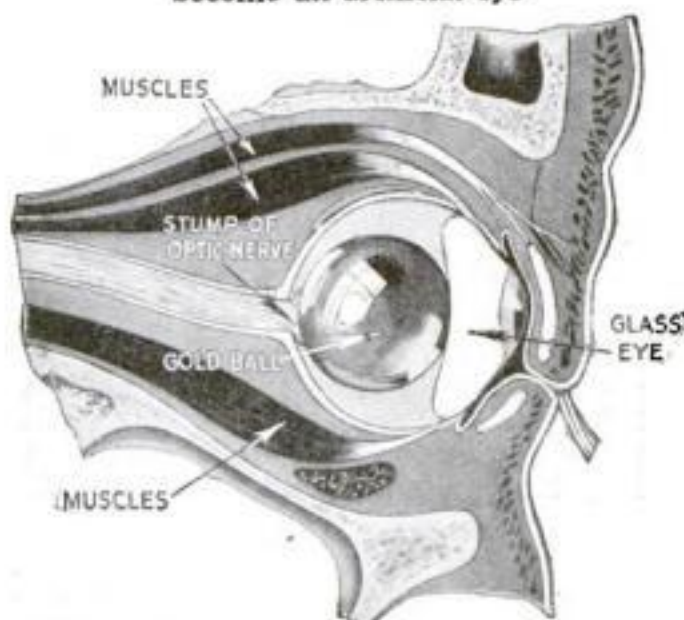
perfection reached by skilful modern artisans in duplicating the shape, size, and color of human eyes.

Working with colored glass "pigments" as a painter would work with his oils, these artisans not only match perfectly the sound eyes of their subjects, but actually have discovered a means of fitting an artificial eye over the nerve stump of a destroyed eye in such a way that the glass eye moves in almost perfect harmony with the subject's sound eye.

This degree of imitative skill, in many cases defying detection, has been developed through centuries of artificial eye-making. The ancient Egyptians wore golden eyes—made of hollow globes of gold, deftly enameled—while the Romans, as early as 500 B.C., pasted on their eyelids shallow earthenware cups, on which eyes were painted.

The modern artificial eye is formed from a long, hollow glass tube, about half an inch in diameter, tinted bluish white or yellowish white, to match the white of the patient's sound eye. On this glass,

Blown from half-inch glass tubes, artificial eyes are "painted" by fusing colored glass into them. At left: Shaping an eye before a blowtorch. At right: Cutting a glass tube, that later will become an artificial eye



How a glass eye is sometimes made to move in harmony with the living eye. A gold ball, lodged on the optic nerve stump and held by the living muscles, forms a movable support for the eye

sealing the end opposite the handle. Holding the handle, he softens this short cylinder in the hot flame. Then he blows through the handle, expanding the glass to form the eyeball.

Now he begins the coloring process. From numerous sticks of colored glass on his worktable, the artist fuses into the glass eyeball colors and shades to match those in the good eye of his subject. To produce the mottled effect in the iris, for example, there are sticks of thinner rods of different colors, twisted and melted together. Similarly, the pupil is reproduced by melting black glass and fusing a small dab of it into the center of the iris.

Fully as marvelous as the manufacture of artificial eyes are the modern methods of fitting it so that it will move exactly like a normal eye. In modern operations, the stump of the optic nerve and muscles are retained wherever possible, so that the artificial eye will move in harmony with the patient's sound eye. Sometimes a gold ball is lodged on the eye stump, which forms a movable support.

Potato Digger and Loader Combined with Tractor

AFTER years of experiment by various manufacturers of farm implements, a combined potato digger and loader has been perfected in which a steel blade, passing under the tubers, lifts them upon a movable open slat conveyor. There the loose dirt and small potatoes are sifted out and the valuable potatoes are carried to a wagon that moves alongside of the machine.

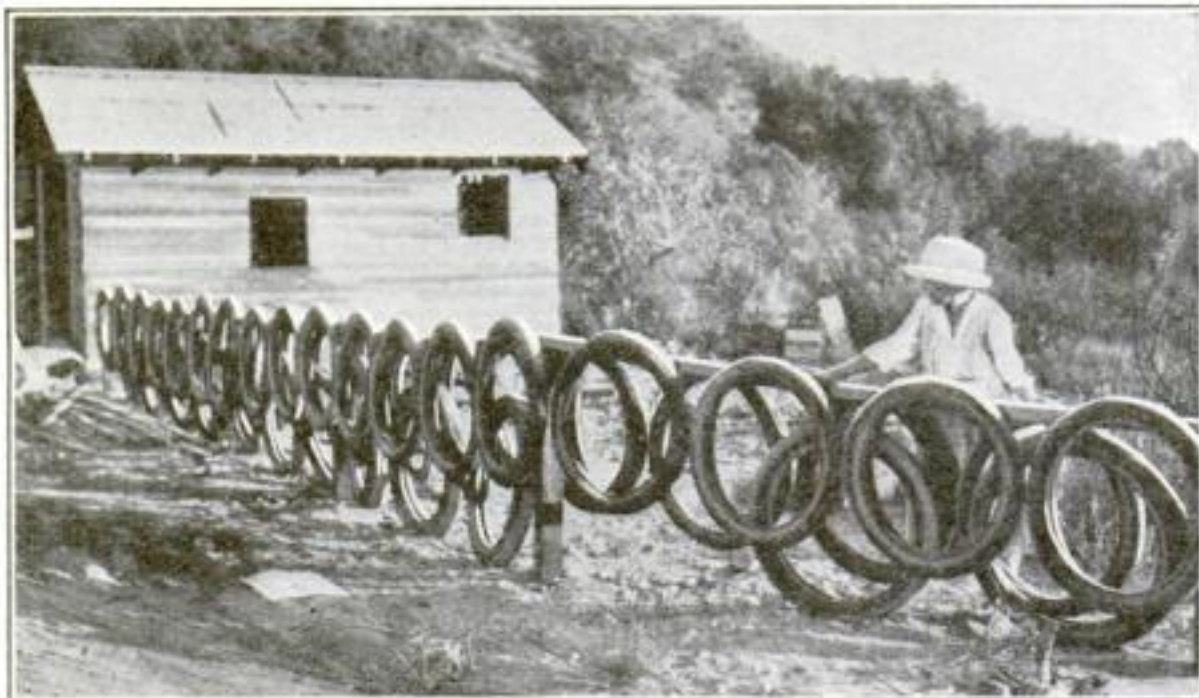


A conveyor carries the potatoes into a wagon moving alongside the machine

The outfit saves considerable time for the farmer, for the usual task of hand picking in the wake of a potato digger is a tedious one requiring many hands and consequently much expense.

A tractor is used to haul the machine along the rows as well as to supply the power required to operate the conveyor elevator. This power is transmitted through a shaft from the motor.

Fence of Old Tires Advertises Garage



SERVICE and clever advertising are combined in a fence built on the premises of a garage near Glendale, Calif. The enterprising owner has used worn-out tires for this unique barrier.

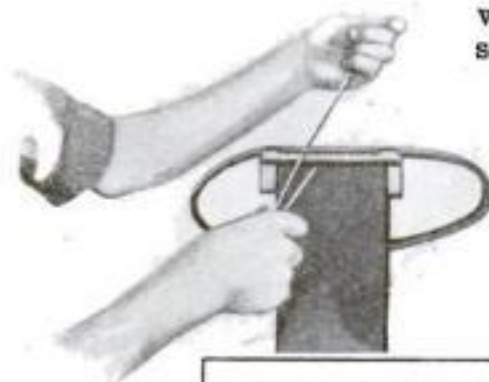
The tires are nailed to a horizontal

bar supported by posts in such a way that they overlap, thus forming a complete barrier. The unique advertisement of the garage's prosperity has attracted the attention of hundreds of passing automobile tourists to the garage.

Ingenious Splice Lasts as Long as Belting

WITH stitches concealed so that they are not exposed to direct contact with pulleys, a belt splice recently patented makes it possible to join small belting, such as is used on an auto fan, so that the splice lasts.

The belting is cut so that one end will have tongues of unequal length that exactly fit into slits cut in the other end. Joined in this manner, the ends are sewed and the stitches are sunk into grooves on the edges of the belting. A special apparatus holds the belt while it is sewed.



Tongued ends of belt are joined and stitched on special vise



Golf Stroke Counter Eliminates Errors

A "STROKE counter" has recently been placed on the market for the convenience of golf players who find it difficult to keep mental track of the number of strokes they require to make a hole. In match games an official scorer is provided, but even then a player likes to keep his own record. In his interest in



the game he is likely to forget his count, and as he neither wishes to cheat his opponent nor himself, the uncertainty often unfavorably influences his game.

The stroke counter, designed to obviate these difficulties, consists of a small snap counter attached to a neat leather strap that is fastened around the wrist of the player. After each stroke the indicator of the counter is moved forward one notch and a distinct click informs the player that the stroke has been registered.

The weight of the counter is insignificant and does not interfere with free wrist movement in swinging a club.

Celluloid Plates for Sign Printing

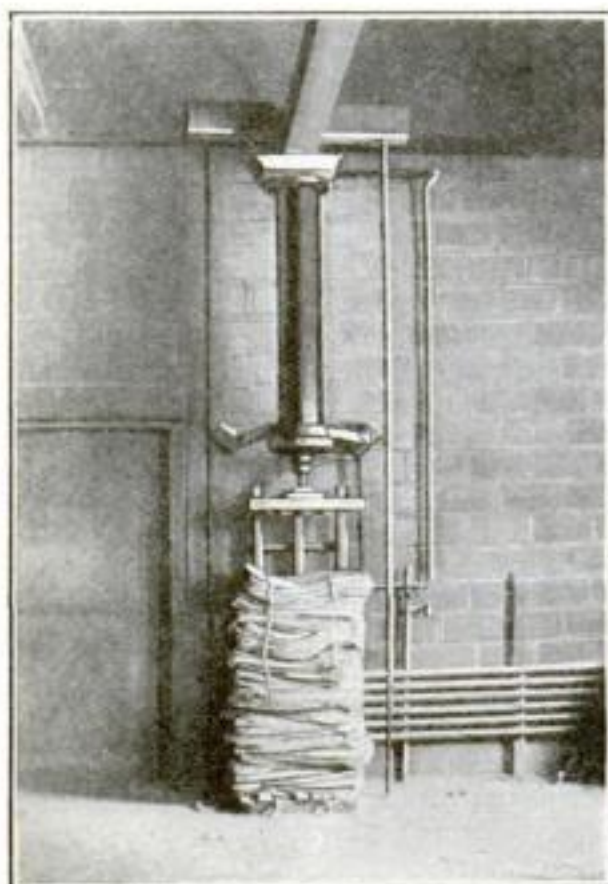
TRADESMEN can save money by printing their own display signs artistically and rapidly with the aid of a new lettering outfit manufactured by a concern in Westport, Conn. No special skill in lettering is required to use the device.

The apparatus consists of 30 frames, each having a different type of lettering. The frame supports a transparent celluloid plate upon which letters have been impressed. A buffer is covered with carbon from a pad and then rubbed over the raised letters on the under side of the plate.

By placing the plate in position and running a pencil over the grooves of the upper surface of the desired letter, the carbon is impressed on the sheet below.



The under side of each letter plate is covered with carbon. Letters are impressed by running a pencil over outlines



Compressed Air Ram Used for Baling Sacks

COMPRESSED air is used in a new apparatus for baling empty cement bags. The device also serves to bale other materials.

A hundred or more bags are placed beneath the ram, a lever is pulled, and the bags are instantly ready in a compact package.

Cords for tying are put in place before compressing the bags and are tightly tied before pressure is released. The ram is said to effect a distinct saving.

WHAT do you want to know? The Information Department of **POPULAR SCIENCE MONTHLY** will gladly answer every reasonable question on scientific subjects. In-close self-addressed, stamped envelope with each inquiry.

Personal Filing Cabinet Is Easily Transported

A PERSONAL filing cabinet recently placed on the market by a New York manufacturer, weighs only 72 ounces without the index, but being of rolled steel, it is fireproof and can stand such abuse as it would receive in transportation. The drop front makes easy the removal of any paper, no matter how full the file may be.

The file has a capacity of 1400 full size letters in addition to the index.



U. S. Needs Rare Metals

AN ATTEMPT is now being made by the government to discover new sources of platinum, nickel, tin, vanadium, tungsten, cobalt, antimony, chromite, and zirconium—minerals that exist in this country only in inadequate amounts or are entirely lacking. The metals experiment station of the Bureau of Mines at Reno, Nev., has undertaken to examine all samples sent to it. In a recent month 87 samples from 10 states were examined and 23 contained elements or compounds of value, including bismuth, mercury, nickel, platinum, uranium, vanadium, and gadolinite.

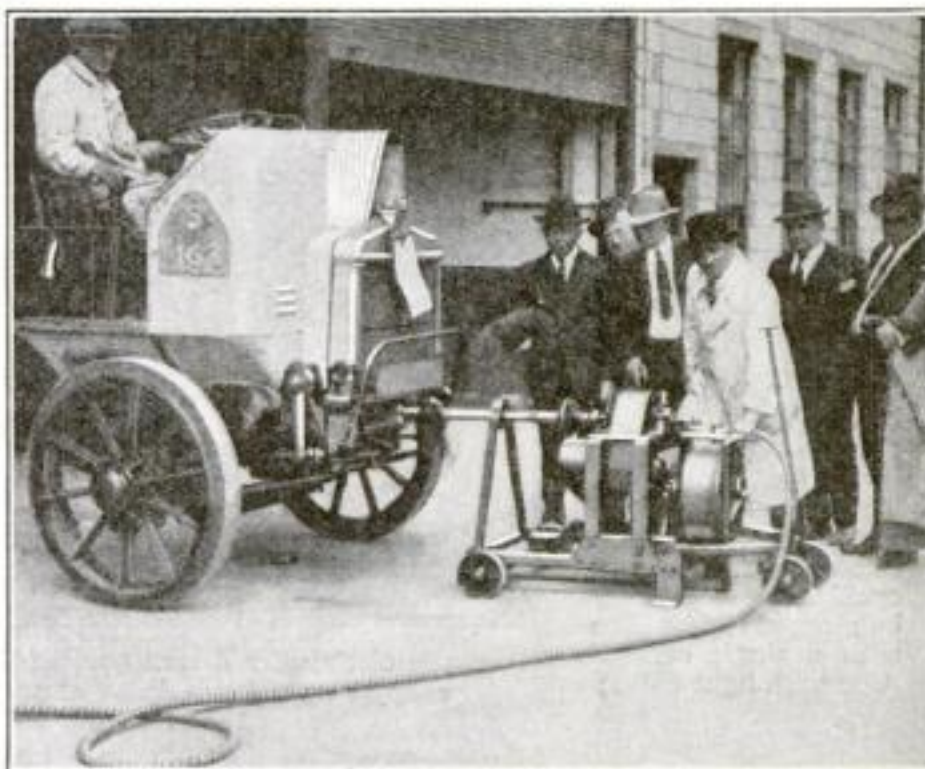
Known geological conditions make it doubtful whether any of these metals will be found here to any great extent.

Cranking Machine Starts Balky Trucks

DIFFICULTIES of cranking the balky engine of a motor truck, especially in cold weather, may be overcome by the use of a newly invented cranking machine driven by compressed air and mounted on a small truck.

The drive shaft of the machine, with universal joint, engages the crankshaft of the truck by means of a clutch. Compressed air is fed into the machine through a flexible tube from a pressure tank. When the engine is started, the clutch is automatically released and the flow of compressed air shut off.

This starting machine was developed



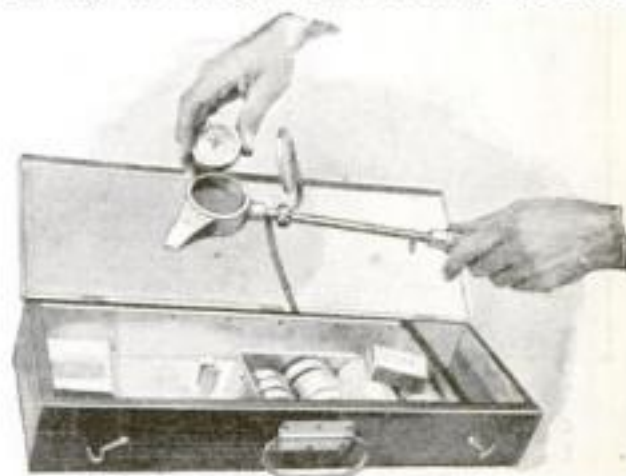
Driven by compressed air, the shaft of this cranking machine engages the crankshaft of the truck by a clutch

from machines that came into use at many aviation fields in Europe and America during the war to facilitate the starting of airplane engines, and was later applied to commercial use.

This Soldering Iron Is Self Heating

A SELF heating soldering iron, recently brought to this country, has a receptacle with a hinged cover into which a capsule containing a combustible material is placed. A special match is inserted in the top of this capsule or briquet and the wooden part of the match is broken off. The cover is then closed, leaving the long head of the match protruding through an

opening in the cover. Another special match is used to light this head and an intense white heat follows instantly, consuming the briquet and heating the iron



A combustible briquet, inserted into soldering iron, supplies the heat

throughout. A single briquet will maintain the iron at soldering heat for about ten minutes. If a longer job is to be done, a new charge is put in.

The iron, briquet, and matches come in a metal lined box.

Blast Furnace Air Preheater Saves Coal



Drawn by the furnace draft through a winding passage, as shown at right, air is preheated for more perfect combustion



AN AIR preheater for house furnaces that utilizes the principle of the blast furnace and thereby, it is claimed, provides a fuel saving of at least 20 per cent, is being marketed by a concern in Richmond, Ind.

It has been proved that the greatest heat in a furnace is in the coal bed. This heat causes dissociation of the coal elements, many passing unconsumed up the flue because air necessary for combustion cannot mix with them.

The new attachment was designed to correct this by drawing in air through the upper door, so that the oxygen of the air can mix with unburned combustible gases that are distilled off. In

order that the air may more readily combine with these gases, it is first preheated by passing it through a winding passage, the walls of which are subjected to the heat of the flames in the furnace. The natural draft of the furnace draws the air through the attachment.

Sandy Loams Fight Frost

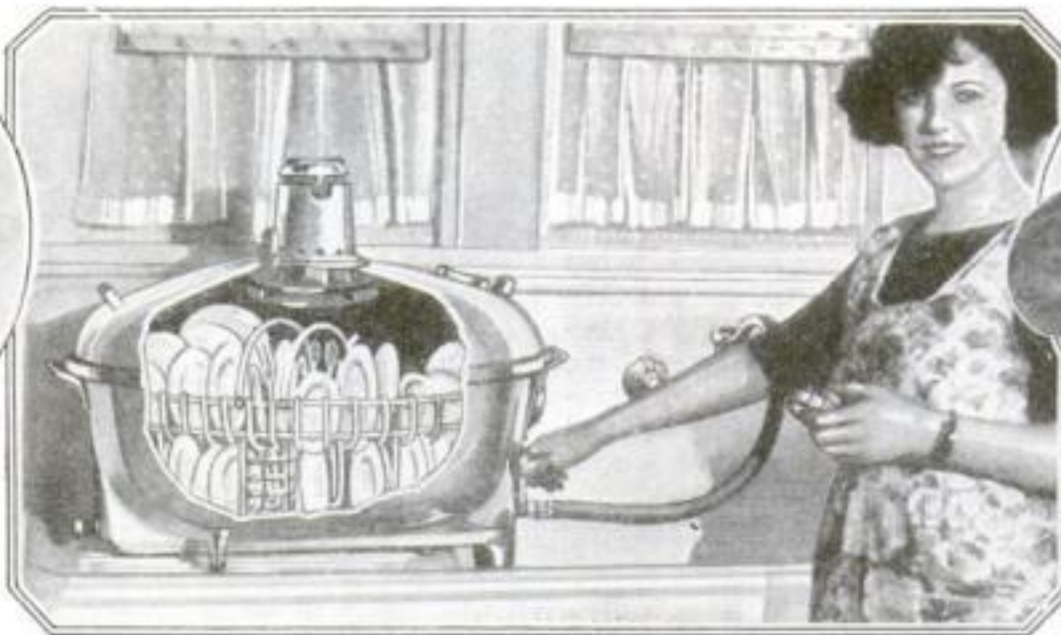
THE truck farmer who selects soil in which there is a sandy component, is in less danger of damaging frosts than if he has loam or clay soil, according to the U. S. Weather Bureau. Moreover, if he keeps his land well drained of surplus moisture and free from weeds, he is less liable to the damaging effects of severe temperatures.

Experiments show there is a relation between the temperature of soil and the minimum temperature of the air, in that sandy soils store up much heat during the day and give this off at night, raising the temperature of the air above it.

Handy New Tools for the Housewife's Workshop



To this portable double socket for table use, two electrical heating or cooking devices may be plugged at one time with a single connection with light socket



An electrically driven suction fan pumps air through the hot, soapy water of this dish washer, agitating the water violently so that the dishes are thoroughly cleaned



This kitchen paring knife has an aluminum guard curved to fit the second joint of the index finger and attached near the handle



For kitchen use, this axlike chopper has double blades, one with a sharp edge, the other with sharp cutting teeth



Built of ornamental silver lattice in lazy-tong fashion this dish holder can be made to fit any glass baking dish, round or oval



The double-hinged cover of this sink strainer may be swung under the strainer as a dripping tray for emptying contents



This small sewing machine lamp, when clamped to the arm of the machine, can be turned so as to throw its light on the work wherever needed



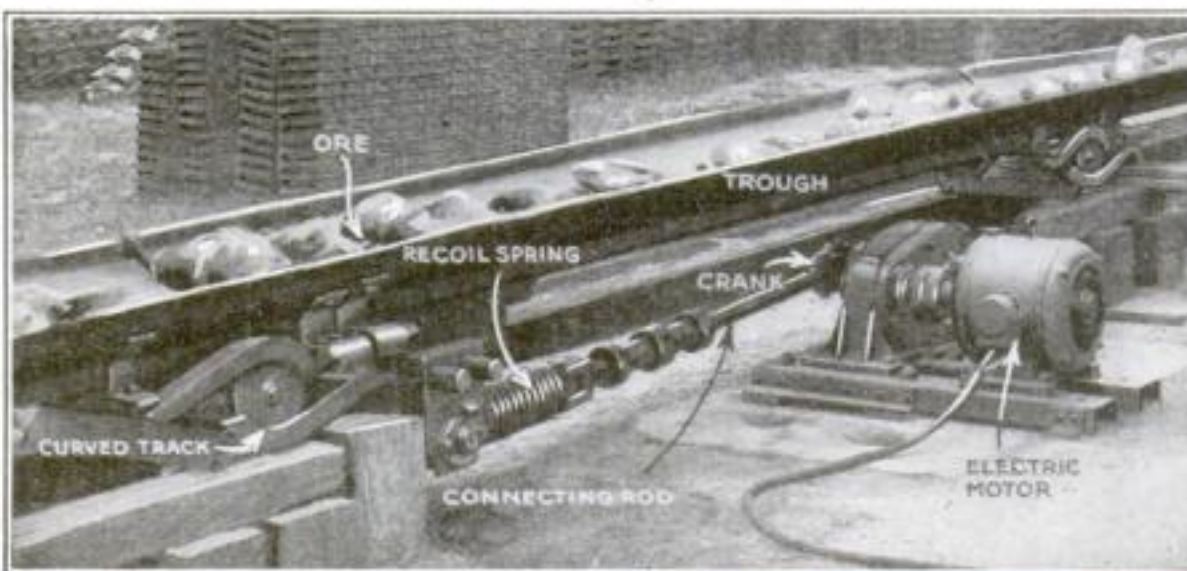
To wring this mop, raise the ring grip from the bottom, then turn the grip



This cellar door switch turns on the electric light in the cellar when the cellar door is opened and turns it off when the door is closed again

Shaking Motion Moves Ore along Stationary Conveyor

AN ELECTRICALLY driven stationary ore conveyor, that carries the ore forward by a shaking motion, consists of a metal trough operated by an electric motor. In addition, an upward motion is imparted by a curved track on which the trough rides. Thus, while the motor drives the trough forward by means of a connecting rod, the upward curvature of the



Driven forward by a connecting rod from the motor, and upward by a curved track, the conveyor trough is suddenly arrested by a coil spring and thrust back to its original position. This shaking motion shoots the ore forward

track causes the contents of the trough to shoot forward and upward at the velocity of the trough.

The forward motion is then suddenly arrested by a powerful spring and the connecting rod carries the trough back. Meanwhile the ore has been given sufficient momentum so that it continues to move forward while the motor executes its return stroke.

Better Days Ahead for the Loudspeaker

Using Cement Horn with Radio Amplifier, Inventor Floods Miles of Countryside with Melody, Giving Entire Rural Community Unique Entertainment



How residents of Waterford, Va., enjoy outdoor radio concerts regularly, thanks to the ingenuity of M. C. Hopkins, inventor of a novel loudspeaker that makes music audible nearly three miles away. Armstrong Perry, famous radio writer, is shown in inset above

By Armstrong Perry

YOU are driving your car along a country road in a prosperous farming community not far from a large city. Suddenly you hear a faint, barely audible melody floating through the air like the strains from some elfin orchestra.

At first you are startled. But as the music increases in volume, you believe it must come from some great-horned phonograph in one of the homes ahead on the road. Yet house after house is passed and the source of the music still seems far ahead. After driving nearly three miles beyond the point where the music was first audible, you come to a charming scene on the outskirts of a small village.

An Idyllic Community Center

In the corner of a well kept lawn beside a stone lodge surrounded by fish ponds, luxuriant shrubbery, and shaded benches built for two, stands a cement horn seven feet high and wide. The whole population of the village seems to be strolling past, lolling in canoes, or hanging over the low wall that borders the estate. And you are suddenly aware of the mysterious source of the music. Radio and the loudspeaker have combined to flood an entire countryside with melody!

This is not a dream, but a straightforward account of what actually happened to me last summer during a visit to the little Virginia village of Waterford, not far from Washington. There I discovered the veritable apotheosis of the loudspeaker. No less grandiose word expresses the impression I received. I have never witnessed a more satisfactory community gathering. It combined the generosity of a prominent citizen, the appreciative response of townspeople, the thrill of novelty, and intense scientific interest.

Curious, I interviewed the presiding genius of this community radio function. I found him to be none other than M. C. Hopkins, a man whose varied career has led

him into music, into the profession of patent attorney, and into the realms of invention, where he was associated with Edison, Alexander Graham Bell, and a score of other scientists. Becoming interested in radio, he consulted with his friend, E. H. Armstrong, the radio wizard, and then went to work in hopes of solving the loudspeaker problem. What I heard on the lawn was the result of his efforts.

Hopkins explained to me that to eliminate certain difficulties he had designed a pick-up or transmitter to take the place of a microphone at the broadcasting station. The elimination of atmospheric interference, and tube noises had been accomplished as far as is possible at present by careful installation and operation of receiving outfits. In addition he tried to design his loudspeaker scientifically both in shape of chambers and horn and in the electrical apparatus and diaphragm that do the amplifying. And he believes that he has demonstrated that sound will travel extraordinary distances, *if the form of the wave is maintained.*

But even Hopkins is not entirely satisfied with results he has obtained. And, until more satisfactory loudspeakers are perfected, the average man must make the best of what is on the market. Substantial progress has been made of late, despite the difficulties involved.

There are two general types of loudspeakers. Simpler ones are horns with devices that make it possible to attach telephone receivers to the small ends. These horns use no energy except that which is delivered from the telephone diaphragm. Some are artistic, some were designed by persons having a knowledge of acoustics; and some are neither. The only way to pick a good one is to have your dealer give you a demonstration of each one.

If made faultily, so that it will vibrate, a horn will produce an unpleasant "blare" in harmony when the note turned into it is caused by vibrations having a frequency the same as its own. The perfect horn is one that will not vibrate, that preserves the

"form" of the sound wave it transmits, and permits the sound wave to reach every spot in front of the horn.

The other general type of loudspeaker has a diaphragm of its own that is actuated by electrical current from a local battery. The most popular device costs \$150, employing complicated apparatus. The manufacturers of this instrument recently have placed on the market another loudspeaker, costing \$55, that may be attached directly to the amplifier of any receiving set, eliminating the expensive power amplifier. Another instrument costs only \$20.

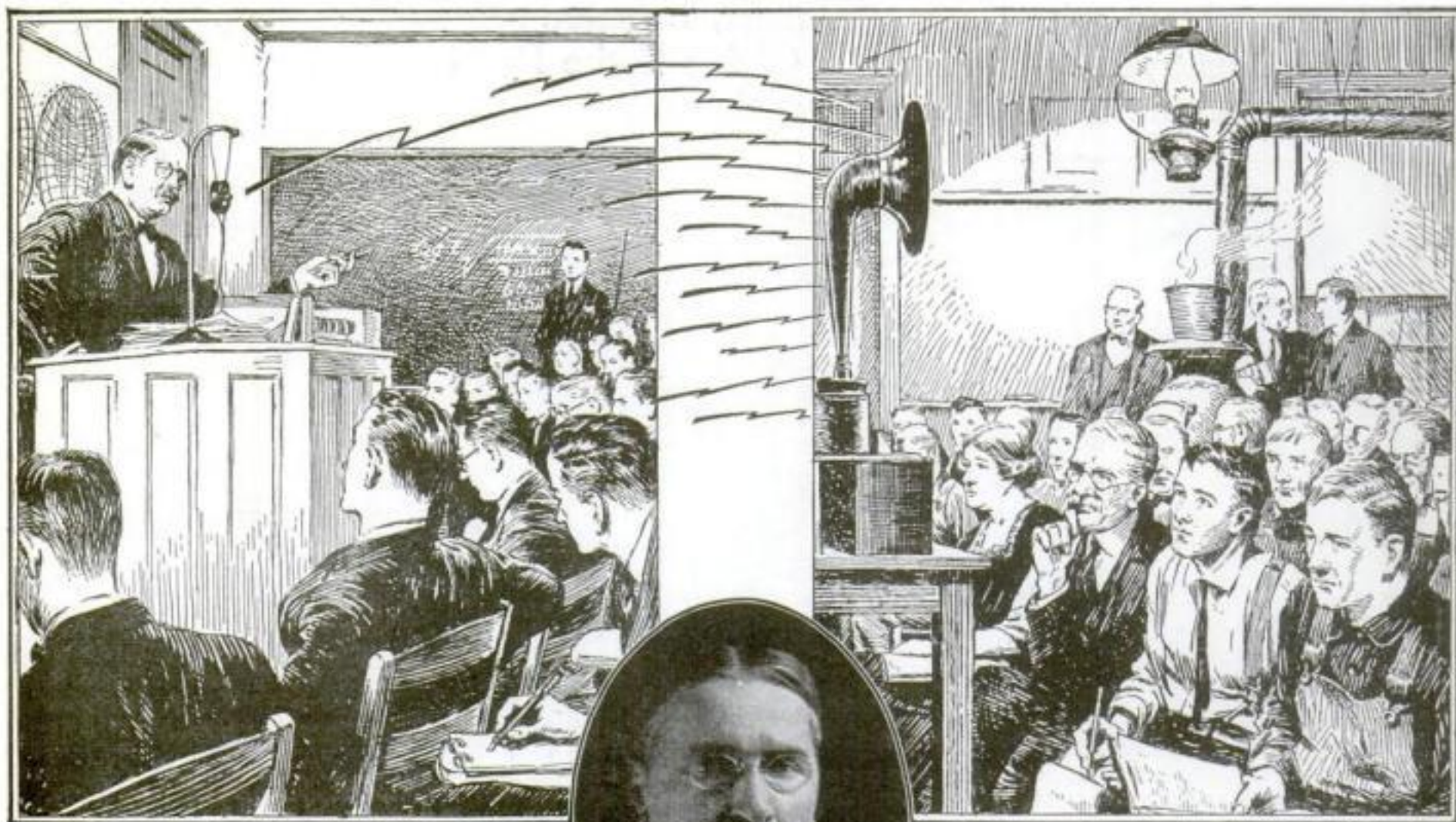
How the Phonograph Is Utilized

Several devices use a phonograph for the loudspeaker. The scientifically designed horn and connections of the phonograph make a good loudspeaker, but results depend entirely on the efficiency of the receiving apparatus. One device consists of a clamp to be slipped onto the arm or neck of the talking machine, a single phone being held in place by a screw. Still others use a Y-shaped attachment to which a pair of phones may be applied.

An interesting new device is attached beside the turntable of the phonograph, connected by wires with the radio receiver and the opposite poles of a six-volt battery. The phonograph needle is placed in a groove in a vibrating armature that protrudes through a slot in the middle of the device. Vibrations produced by the current received through the radio set are passed on to the needle so that sounds issue from the horn. When strong amplification was used, I found the music came through with phonograph quality, although with some distortion.

These, then, are the newer developments of loudspeakers. They are not entirely satisfactory, it is true, but there is every reason to believe that with more intelligent receiving and broadcasting, coupled with advances in invention that must surely be made, we may look for much better things in the near future.

Professor-Inventor Predicts "Radio Universities"



The "radio university" that Prof. Michael Pupin, of Columbia University, believes is sure to come with the further development of the loudspeaker. From the classroom where the university professor lectures to a group of his students—

Radio will carry a wealth of authoritative information and scientific knowledge to hundreds of town halls, factories, and fire-sides, offering a higher education to thousands of men and women to whom such training has hitherto been denied



Prof. Michael Pupin

Professor of physics; head of the Phoenix Research Laboratory at Columbia University, and inventor of the Pupin coil, which made possible transcontinental telephony

A COLLEGE education for every one who wants it.

A university in the home, in the factory and mill, and in the public hall.

An "aerial soapbox" for the forces of economic progress and right.

A complete course in practically any of the subjects now named in the college curriculum—for five dollars; an elementary course in these subjects for one dollar, and a single, far-reaching lecture on one of them by a worldwide authority for ten cents.

Vitally necessary education for the poor, the working man, and even the convict.

In other words, "The Radio Extension University."

"THESE are achievements I see directly ahead, and but one thing stands in the way of their actual accomplishment—the perfection of the loudspeaker," says Prof. Michael Pupin, in an exclusive interview with POPULAR SCIENCE MONTHLY. "When that day comes, Columbia University will be ready to prepare a carefully planned program for the Radio Extension University."

"Months ago, when the full significance of radio dawned on a surprised world, there formed in my mind a vague idea of what radio might some day mean to a university. Today, with radio broadcasting far advanced, that dream has become an almost certain future accomplishment."

"Here is the 'Radio Extension University' as I picture it:

"First, a great university like Columbia, equipped with a powerful broadcasting station for distributing to a knowledge-hungry people some of the vast store of authoritative information and knowledge accumulated by its great professors and

teachers. Surrounding the university, within a radius of 100 miles, are scores of halls and public meeting places, each equipped with a radio receiving set and a powerful loudspeaker capable of amplifying voices without distortion.

"At the university broadcasting station an internationally famous professor, in his classroom, is delivering a lecture on some fascinating new chapter of, say, natural science. Simultaneously, in a hundred distant meeting places, crowds not unlike those at our theaters or public concerts are gathered before the loudspeakers, listening. Each person in the halls has paid 10 cents for the privilege, first of hearing the lecture by radio, then of submitting answers in a written examination covering the rudiments of the subject on which the broadcasted lecture is delivered."

Western University Broadcasts History

AN IMPORTANT step toward accomplishment of the Radio Extension University, as predicted in the accompanying interview by Professor Michael Pupin, of Columbia University, already has been taken by the University of Washington, Seattle, Wash., where lectures in history have been successfully broadcasted, despite the shortcomings of the loudspeaker.

"In each of the 100 halls 1000 persons—100,000 persons in all—are receiving an education without even leaving the limits of their own neighborhoods!

"Such a picture represents, to my mind, what radio may mean soon as a broadcaster of useful knowledge and as a disseminator of vital information."

"Go a step further. Enter a factory or mill of the future. It is lunchtime and, having finished their noonday meal, workers are lounging about on benches in an assembly room or one of the larger rooms of the factory. Some have pencils in their hands and are busily taking notes, while from the horn of a radio loudspeaker the voice of a university professor is carrying to them the higher education that has been denied them."

College Education for Convicts

"Another picture: Sing Sing prison, with its bare interior lighted up by huge arc lamps. In the cells around the courtyard, convicts seated on their bunks are listening intently to the radio report from some far-off university coming to their ears through the medium of a loudspeaker."

"Just one more picture and you will have grasped the significance of the plan for a radio extension university. Here is a home in which an ingenious youth has installed a homemade radio outfit with a loudspeaker. The entire family is listening as the lecture comes in, while the youth takes notes so that later he may pass a written examination on questions mailed to him from the university."

"As I have said, these are real possibilities, not dreams, as soon as the loudspeaker is perfected, and I think that day is near."

Jack Binns' Ten Radio Commandments

Fourth Series: Two Big Problems of the Moment— The Loudspeaker and Radio Frequency



Jack Binns

THE long-distance bug has bitten the radio fan, inoculating him with the desire to hear what the broadcasting stations across the continent have to say.

How can this long distance be achieved? Undoubtedly the best way is by the use of radio frequency amplification, and it is my purpose this month to guide the radio fan in its use.

Briefly stated, radio frequency amplification consists of building up the very weak currents received on an aerial, so that signals that normally could not be heard, are easily reproduced in the receiver. However, radio frequency amplification alone does not give volume in a loudspeaker. That can be obtained only by means of audio frequency amplification. In this connection it may be well to state a few pertinent facts regarding loudspeakers.

1. Know Your Loudspeaker

THE ideal loudspeaker has not yet been developed; but a few types on the market give admirable results when handled properly. These instruments fall in two general classes—those using auxiliary current, known as "electrodynamic loudspeakers," and those that merely employ sensitive phone receivers attached to the horn, perhaps the more popular method.

In using the phone receiver loudspeaker, bear in mind that if the current from the receiver is passed through the magnet coils of the loudspeaker in the wrong direction, they will become demagnetized, reducing the efficiency of the instrument. It is important, therefore, to determine the polarity of the coils as well as of ordinary head telephones. Many manufacturers are now marking telephone cords so that no mistake can be made.

If, by mistake, the speaker is wrongly connected and its magnet demagnetized, the situation may be remedied by carefully reversing leads to the receiver and then passing more than the usual amount of current for a considerable time until molecules of the iron magnet rearrange themselves and reconvert the metal back to a permanent magnet. A loudspeaker will not function properly unless the output of the radio receiver is of good quality; hence tuning is of prime importance.

2. Know Your Radio Transformer

YOU will be able to get the best out of radio and audio transformers by understanding their separate functions. The radio transformer deals with currents oscillating at frequencies far above human hearing; the audio transformer works on currents pulsating at frequencies that correspond to the range of vibrations audible to the average person.

Both types of transformers consist of two coils of wire, one called the "primary" and the other the "secondary." The secondary coils of the audio transformer may have

By Jack Binns

from three to 11 times as many turns of wire as the primary coils, the object being to obtain a step-up ratio between the two.

In the radio transformer, on the other hand, the primary and secondary coils have an equal number of turns, this being necessary because of the remarkable quality of resonance that is encountered at high frequencies. With this arrangement, the amplifying properties of the vacuum tube are used to produce the necessary amplification, because of the fact that a small current in the grid circuit releases a large current in the plate circuit. The vacuum tube, therefore, is an amplifier in itself.

So far as high frequencies are concerned, the problem in radio amplification is to transpose the output of one vacuum tube to the input circuit of the other. Although there are three ways in which this can be done, experience has taught us that the method that uses transformer coupling is the best on high frequencies.

Our radio transformer is really nothing more than a coupled, tuned circuit that is in resonance with a very narrow band of wave lengths, taking the output of one vacuum tube on its primary and—by reason of the inductive coupling between its wind-

reason, windings should be of as small a diameter as possible. Fourth, the number of turns should be just sufficient to produce the correct amount of inductance and capacity for the range of wave lengths for which the transformer is to be used.

3. Place Your Trust in Short Leads

JUST why should you avoid all unnecessary capacity in the use of radio frequency amplification? In explaining the reasons, let's consider the 360-meter wave length, since most of us are chiefly concerned with the reproduction of music and speech from broadcasting stations.

It is generally understood that there is a direct relationship between wave length and the frequencies of magnetic waves that surge through space. For a wave length of one meter, this relationship is 300,000,000 cycles a second; for a wave length of 3000 meters, it is 100,000 cycles a second. In other words, if we know the wave length, we can determine the frequency by dividing 300,000,000 by the wave length in meters. Thus, the 360-meter wave has a frequency of 833,333 cycles a second.

Now, to understand the importance of capacity in a circuit using the 833,333-cycle frequency, consider the nature of its action. If a condenser is joined in a circuit, and a direct current placed on the circuit, the moment the current is applied, a small charge will be placed on the condenser, after which further action will be stopped. Reversing the direction of the current will put an opposite charge on the condenser.

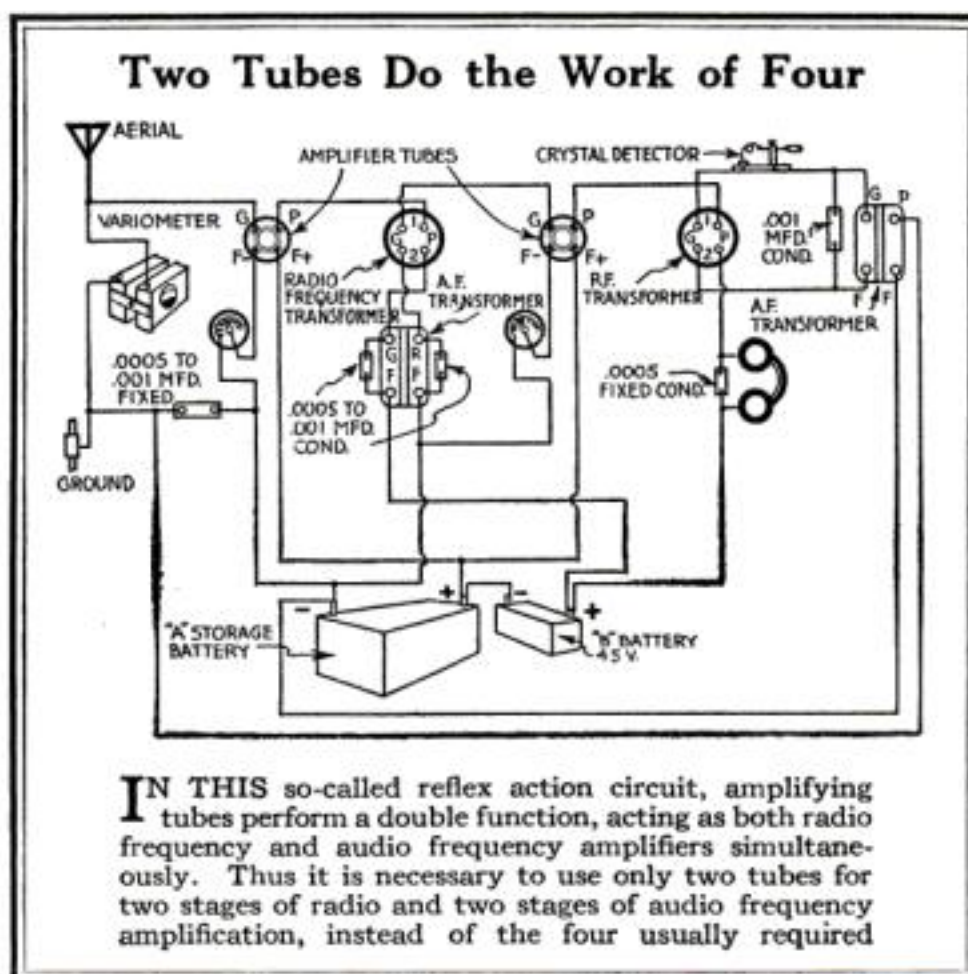
If we place an alternating current, instead of direct current, on the circuit where the condenser is used, this same charging and reversal will take place at the rate at which the current is alternating. In other words, with a 60-cycle current, there will be a current passage through the condenser 120 times every second, or once for every alternation. For currents corresponding to those used on the broadcasting wave lengths, where the frequency is 833,333 cycles a second, it will be readily seen how

the condenser offers an easy path.

And, since two insulated wires close to each other act as a condenser, it is imperative that all connecting wires be kept as short as possible. Otherwise the capacity will be increased. This cannot be emphasized too strongly, especially in the leads from the tuner to the vacuum tubes and the wires connected with the tube grids.

4. Make Tuning Elements Simple

IN RADIO frequency amplification you are using what is practically a tuned circuit between each tube, and to an extent this is equivalent to a multiple tuned

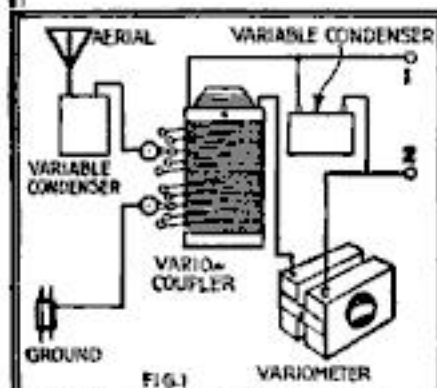


ings—transferring this to the secondary, which, in turn, impresses the current onto the grid of the next tube. Thus the radio transformer is a means of transporting the amplified result of one tube to the next tube for further amplification.

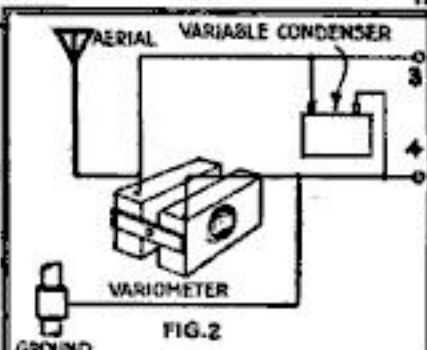
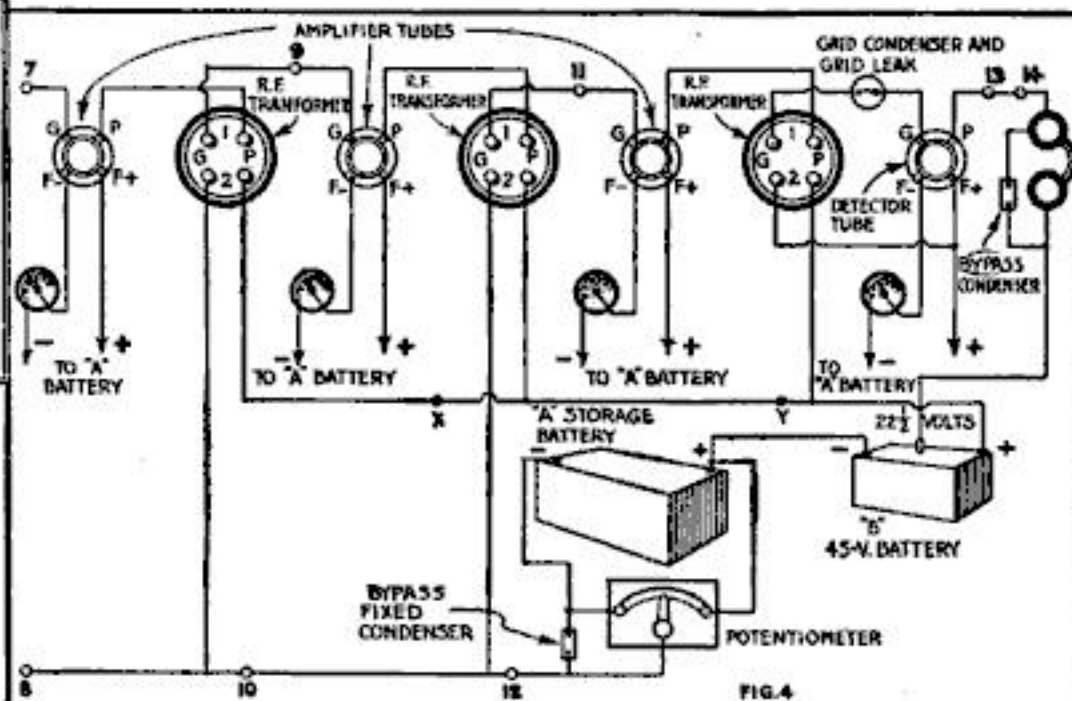
For successful operation of the radio frequency amplifying receivers, the transformer should have these characteristics:

First, it should be completely shielded. Second, its coils should be wound in such a way that the capacity effect is at a minimum (reversal of the secondary leads sometimes produces this effect in badly designed transformers). Third, for the same

Various Ways to Hook Up Your Radio Frequency Set



The diagram above shows a variometer tuning circuit that can be used with the three-stage amplifying circuit (at right). To use this tuner, connect terminals 1 and 2 with terminals 7 and 8 respectively in the radio amplifying circuit



The variometer tuning circuit above is another tuning element that can be used successfully with the radio frequency amplifying circuit at the left. Connect terminals 3 and 4 with terminals 7 and 8 respectively, in the radio amplifying circuit

circuit, because transformers will refuse a pathway to any wave length that does not come within their range. This, in conjunction with the necessity of keeping the capacity as low as possible, makes it absolutely imperative that only the simplest form of tuner should be used.

In cases where an aerial and ground are used in a radio frequency receiver, it is best to have a loose-coupled tuner to obtain the best selectivity and eliminate troublesome capacity effects. In my work recently with this form of amplification, my tuning element consisted solely of a short wave variometer in the aerial circuit with a half inch lead from the aerial side of the variometer to the grid of the first tube, and another lead of the same length from the ground side of the variometer to the center tap of the potentiometer. This arrangement, I found, gave me ample selectivity and great efficiency.

If you use a loop aerial with your radio frequency receiver, it is necessary to use a variable condenser in order to tune the loop to the wave length required. The condenser, however, should have as small a capacity as possible and leads to and from it should be as short as the set will permit.

For radio frequency amplification, elaborate tuning apparatus is entirely unnecessary. Rheostats are not necessary either for radio or audio frequency tubes, although a rheostat is needed for the detector. Thus the circuit is limited to three controls—the tuning element, the potentiometer, and the detector rheostat.

5. Trust the Potentiometer

IN RADIO frequency amplification the potentiometer, a variable resistance device, is the stabilizing element that keeps the entire set under control. The instrument consists of a fixed resistance placed squarely across the A battery. Its variable connection forms a third contact point with an arm that moves across the resistance, thus enabling the operator to take a voltage of any amount for use in the circuit with which it is connected.

In the case of radio frequency, this voltage is for the grid-filament circuit through the tuning coil connected with the radio

THIS three-stage radio frequency amplification circuit may be used with any of the three tuning elements shown in Figs. 1, 2, and 3. In using all three stages of amplification, connect the tuning element with terminals 7 and 8. For two stages, connect tuning element with terminals 9 and 10 and break the circuit at X. When only

one stage of amplification is to be used, connect the tuning element with terminals 11 and 12 and break the circuit at Y.

The use of regeneration with this type of circuit is not advisable; but regeneration can be used by breaking the circuit between terminals 13 and 14 and connecting the leads of a variometer with the terminals

frequency tube. The potentiometer permits us to put a voltage of any amount upon the grid of the radio frequency tube. This voltage may be but a few milli-volts.

Now to keep the entire set in a state of equilibrium it is necessary that the grids of the amplifying tubes be negative with respect to the filaments. The extent to which the grid is negative with respect to the filament depends upon conditions in the set and must be determined by adjustment. That adjustment is just what the potentiometer is for. Consequently, the adjustable arm of the potentiometer will be on the side of the resistance element in such a position as to put the negative bias on the grid. Louder signals are obtained when the arm is on the positive side of the resistance element, but more stable results are obtained from the negative side.

6. Use a Battery Switch

REMEMBER that because you are using a potentiometer across the A battery, you are slowly discharging the battery. If this arrangement is allowed to remain when the set is not actually in use, the battery will soon run down.

Use a battery switch, therefore, and disconnect the storage battery when the receiver is not being used.

7. Use a Loop wherever Possible

SINCE a loop aerial is highly directional in its effects, it serves as an excellent tuner, cutting out 50 per cent of interference. The loop will receive signals only when it is pointed in the direction of the broadcasting station to which you wish to listen. Stations located at right angles to

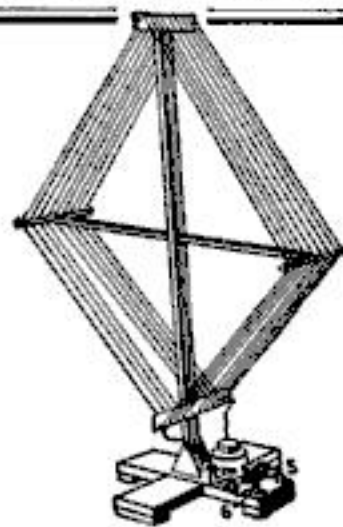


FIG. 3

To use this loop aerial receiving tuner with three-stage radio frequency amplifying circuit of the type shown in central diagram above, connect terminals 5 and 6 with terminals 7 and 9 respectively

the plane of the loop will be entirely eliminated.

For broadcasting reception the loop can consist of eight turns of No. 18 annunciator wire wound on a square frame three feet to a side. These turns should be carefully spaced one half inch from each other.

8. Use Only Hard Tubes

A SOFT or detector tube cannot be used successfully as an amplifier, because it is decidedly critical as to voltages. At present there is no well designed tube for radio amplification. As a result, transformers have been designed for tubes on the market.

9. Transfer Tubes in the Circuit

ALTHOUGH vacuum tubes are now made in quantity from standard designs, no two are identical. In receivers employing more than one stage of radio frequency amplification, it will be found that reception will be greatly improved if the tubes are changed from one socket to another until the most effective combination is obtained. This holds true for audio frequency amplification as well as for radio frequency amplification.

10. Regeneration and Radio Amplification

MANY fans ask whether it is possible to add one or more stages of radio frequency amplification to their standard regenerative receivers. The answer is that such addition can be made, but that it is not advisable for these reasons:

First, because you should keep your radio frequency set as simple as possible. Second, because of the capacity coupling between the elements of the vacuum tubes, radio frequency amplification contains all the elements of regeneration in itself. The amplification obtained from three stages of radio frequency is so remarkable that no further addition should be necessary. It would be gilding the lily.

Why Tires Wear Out and How to Save Them

Important Facts about Tread and Fabric that Will Help You
Cut the Cost of Driving Your Car in Winter

By Harold F. Blanchard

WINTER is the time when tires suffer most. Sharp pieces of ice cut and tear the tread, while icy ruts rip the side walls to shreds. Pieces of ice are picked up by the tire, and later, when the car is in a warm garage, the ice turns to water that rots the tire structure.

On snowy, slushy, and rainy winter days, tires are subjected continuously to the ravages of moisture, their arch enemy. Frozen roads or sharp stones cut holes in the tread through which moisture can reach the fabric underneath. Then rotting sets in, and as the holes grow larger, mud and perhaps some oil enter. Gradually the moisture, like so much acid, eats through layer after layer of fabric until a spot becomes so weakened that the tube blows out through it.

The first step in protecting tires against their winter enemies is to examine them frequently for cuts. Whenever a cut is found, it should be filled with a rubber compound. If the cut is very large, better take the tire off and have the hole vulcanized. Don't fit tire chains too tightly. Unless the chain has opportunity to slip, the cross links will wear the tread.

ALTHOUGH a tire is welded into a single piece, it is really a rather complicated structure, as the sectional drawing on this page clearly shows. If you expect to obtain low cost to the mile you must not only care for your tires properly, but you must have well built tires to start with. Beads must be strong to hold the tire on the rim. The cotton fibers must be sound, for the failure of even a few of them at one spot will eventually produce a blowout. The tread must be tough, while the layers of cushion gum of nearly pure rubber must be proportioned and tempered with care.

Once the tire structure is understood, it is not hard to realize just how, when, and why a tire can be abused. The most frequent form



The Ten Parts of an Automobile Tire

1. Tread—A tough outer sheath of rubber compound built to withstand continuous contact with the road. Before vulcanizing, it is compounded with sulphur to give it hardness. Lampblack or zinc oxid is added to toughen it.

2. Breaker strip—A loosely woven piece of fabric resting on a thick layer of cushion gum. It distributes thrusts of sharp stones, etc., over a comparatively large area and thus protects the fabric underneath.

3. Side wall rubber—A rubber compound protecting sides of the tire.

4. Wire—Piano wire is usually employed in building the bead core.

5. Bead reinforcement—A layer of fabric wrapped around the triangular shaped bead. It strengthens the side walls just above the beads, where the tire receives the most bending.

6. Bead core—Usually numerous piano wires embedded in rubber and fabric.

7. Beads—Tough rubber portions of the tire that come in contact with the rim.

8. Filler for bead core—A combination of rubber and fabric.

9. Carcass—The tire foundation laid in layers, either of cord or fabric, separated by cushion gum.

10. Cushion gum—Nearly pure rubber, soft and elastic; acts as a spring contact between the fabric carcass and the breaker strip on which the thread is mounted.

of neglect is to run it with too little air, which produces the same disastrous effect as overloading a tire that is not large enough for the weight it must support. Insufficient air bulges out the tire carcass so that at the point where the tire flattens over the rim, some of the fibers in the inner layer of fabric will stretch beyond their strength and break.

If the interior of the tire is examined, a slight fuzz will be observed along the inner surface. This means some broken fibers. Little by little, more fibers will break, until all the fibers in the inner layer are broken and a definite crack develops. Then the next layer will crack, and so on. Finally, one of two things will happen: The tube may be pinched in the crack and thus the tire will go flat, or the crack will develop until the last layer gives way, causing a blowout.

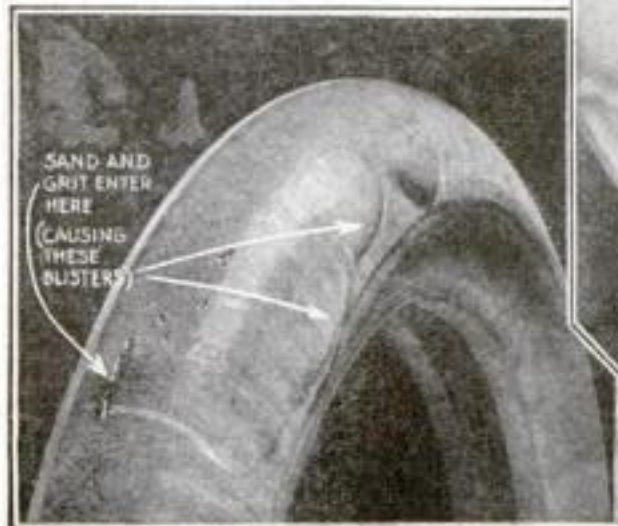
A cord tire is not so likely to be injured by underinflation as a fabric tire. When a fabric tire is flexed, the longitudinal threads are bent around the cross threads, and thus are greatly strained.

This condition is eliminated in the cord tire because the threads in each layer of "fabric" lie flat and parallel. For the same reason friction also is less in the cord tire.

Friction generates heat, and if internal friction is excessive, the tire temperature may rise high enough gradually to vulcanize the rubber to a point where it will lose its strength. Then the layers of fabric will begin to separate, and in chafing against each other will wear and produce still greater heat, causing destruction of the tire.

The development of a blowout may be likened to breaking a flexible wire by bending it back and forth repeatedly. The blowout may start with the failure of a few small fibers at a certain point.

Added strain thus is thrown on adjacent fibers, causing further breakage until some of the threads are severed. Then more threads break, and the fracture spreads through one layer of fabric to another, until the tire at this point



How a small neglected cut grows into a blister, then a blowout. Moisture, sand, and oil enter, separating tread from fabric and finally rotting fabric



Here's an easy and effective way to patch a tread cut. With a blunt tool force into the cut a piece of plastic rubber that you can purchase in convenient cartons. Then cut off the unused filler even with the tread. Careful attention to each small cut will prevent blisters like those shown in insets



To remove sand and grit from a blister, open the blister at the point farthest from the tread and scrape out the accumulation carefully

can no longer withstand the outward pressure of the tube and gives way.

A blowout may be started by any excessive strain such as running over a sharp stone, striking the edge of a curb, running tires too flat, or it may be caused by weakness in the carcass itself. Rotting of the fabric by moisture, dirt and oil is another common cause.

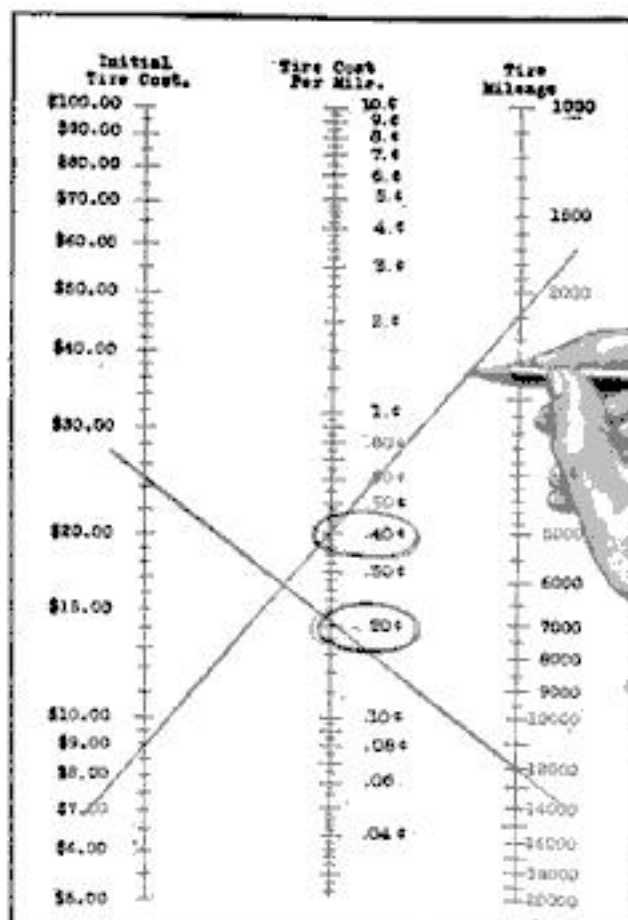
When the tire is built, its cotton structure is protected against the elements by a strong exterior of rubber. But in use, if a cut is deep enough to pierce the rubber, rotting will begin. The size and depth of the rotten spot gradually grows until it becomes so weak that the tube blows through. Sometimes the spot will spread entirely around the tire, loosening the tread as it goes, and rotting the outer layers of fabric underneath, with the result that when the tire finally does blow out, most of the tread is loose and the outer layers of fabric are completely destroyed.

How to Avoid Blowouts

The best ways to prevent such blowouts are these: First, avoid cutting objects such as glass and razor edge switch frogs by alert driving. Drive over sharp stones slowly. Avoid car tracks, and especially switches, as much as possible. Be doubly cautious in wet weather, because wet surfaces cut rubber more readily than dry surfaces. The tires should be examined occasionally for deep cuts and whenever one is found, it should be filled with some compound specially prepared for this purpose, or if the cut is very large or deep, it may be advisable to take the tire off and have it vulcanized. If the fabric underneath has not rotted, this repair will be a very simple one and should not cost more than a dollar.

When a tire blows out while the tread is still good, examine the carcass carefully. If there is extensive looseness of tread or fabric, or if there are incipient checks or cracks on the interior, areas of rotted fabric or rim cuts, it is usually best to discard the tire. You can detect loose or rotten fabric by feeling for a soft spot when the tire is off the wheel. To detect loose tread, grasp the beads in your hands and compress the tread with your thumbs.

If a tire is to give full satisfaction, every detail of its construction must be right; and that is the best reason for buying new

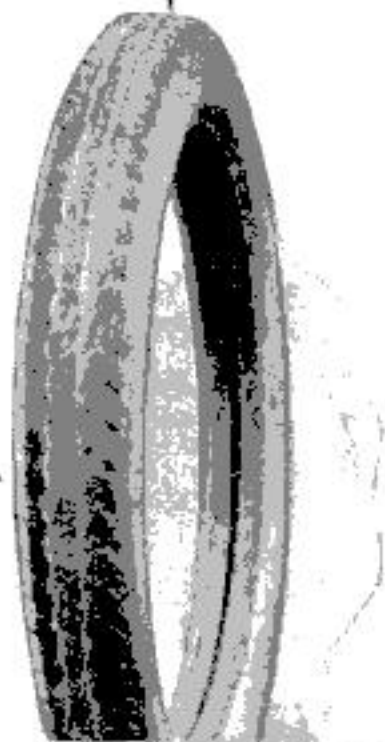


Why Well Built Tires Cost Less in the End

THIS chart shows how you can cut tire bills by buying first class tires. For example, a \$9 tire, good for, say, 2200 miles, will cost you four tenths cent a mile, while a \$25 tire, good for 12,000 miles with proper care, costs only two tenths cent a mile, or half as much as the \$9 one.

Clip out this chart and use it to keep a record of what your tires cost you. From a point in the left hand column corresponding to the initial cost of your worn out tire, draw a line to the point in the right hand column corresponding to the total mileage of that tire. Where this line intersects the center line, read the cost to the mile.

At right: What happens to a tire tread when wheels are out of alignment. Note the worn path clear around the circumference. This can be prevented as shown below



Running in frozen ruts and against curbing ruined this perfectly good tire. Note how the light rubber of the side walls has been broken by friction



One simple way to determine whether your front wheels are in alignment, and so prevent excessive tire wear. Measure the distances between the centers of the tires at the front and the rear. Besides being in alignment, the wheels should "toe in"—that is, they should be closer together at the bottom than at the top

tires of good quality; you never can be sure about "tire bargains" or "seconds." Usually there is something seriously wrong with a second, although the defect is rarely apparent. Its tread may be too hard or too soft, and defective in wearing quality, either because of the wrong amount of heat or wrong compounding of the rubber.

A layer of fabric may have been accidentally left out or the tire may be mold pinched.

"New tires" that sell at "bargain prices"—say from three to five dollars—are usually junk tires made over. Blowouts have been hastily repaired, a thin layer of fabric has been added to the inside and a new tread placed on the outside. Frequently such treads are largely composed of pitch com-

pounds with just enough rubber to give a rubber smell. These treads will not last more than 50 miles.

Retreaded tires don't pay. Their cost to the mile is rarely as low as that of good new tires. The chief objection to them is that the treads come loose, the carcasses are usually overcured if heat has been used to apply the treads, and finally, after the original treads have been worn off, the carcasses are rarely in much better shape than the treads.

It pays not only to buy good tires, but it also pays to repair them carefully. Cold patches, while easy to apply, are uncertain, and they should be used only on a light car driven slowly. Usually it costs not more than 25 or 50 cents to have a punctured tube repaired by an expert tire man. Then you are reasonably certain that the job has been done correctly. If you prefer to do your own work, a small portable tube vulcanizer, costing a dollar, is far superior to a cold patch.

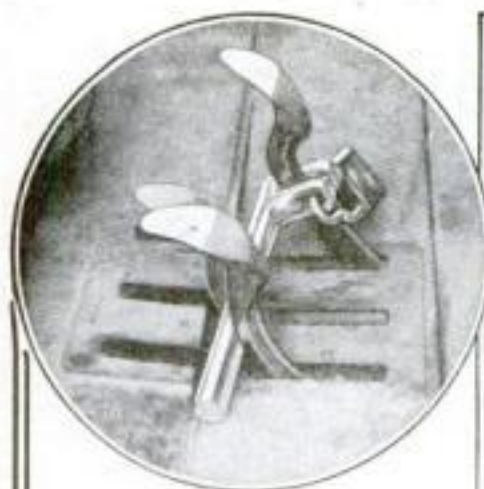
Protect the Tube

In repairing a straight-side tire, a canvas strip or flap should be inserted between the tube and the rim side of the shoe to protect the tube. Don't use a flap that is torn or frayed, for it is likely to pinch the tube. A large puncture hole should be covered with a small patch inside the shoe to prevent tube pinching.

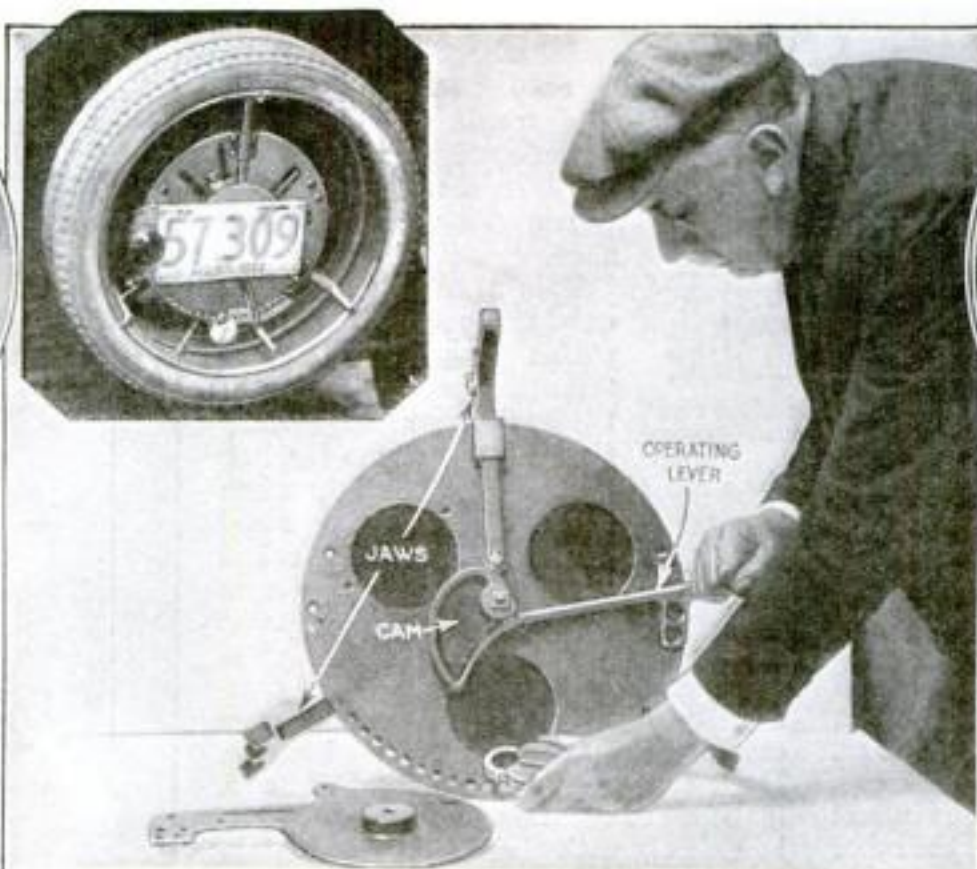
Avoid skidding around corners, and be careful not to allow the brakes to lock the rear wheels. In just a few seconds of sliding, more rubber may be worn off a tire than in hundreds of miles of running. The brakes should be carefully equalized so that they will go on with equal force; otherwise one wheel may lock long before the brake acts appreciably on the opposite wheel.

(Continued on page 75)

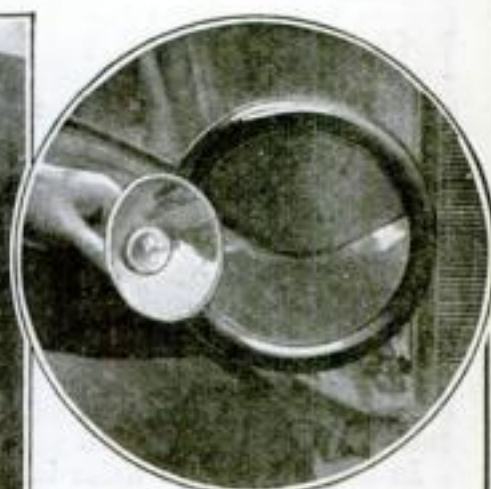
Theft-Proof Tire Holder—Other New Accessories



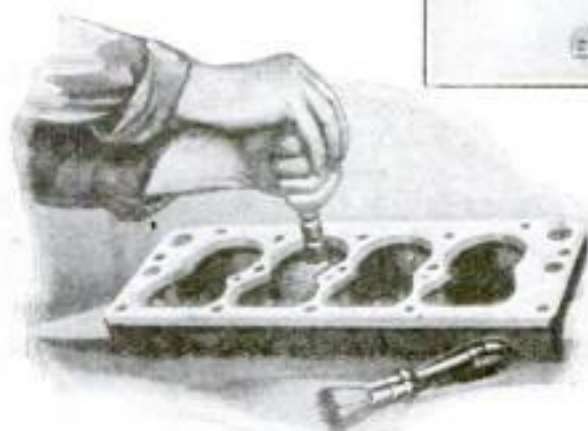
This safety lock for Ford cars consists of an iron bar slipped between the reverse and gear levers and locked to the brake



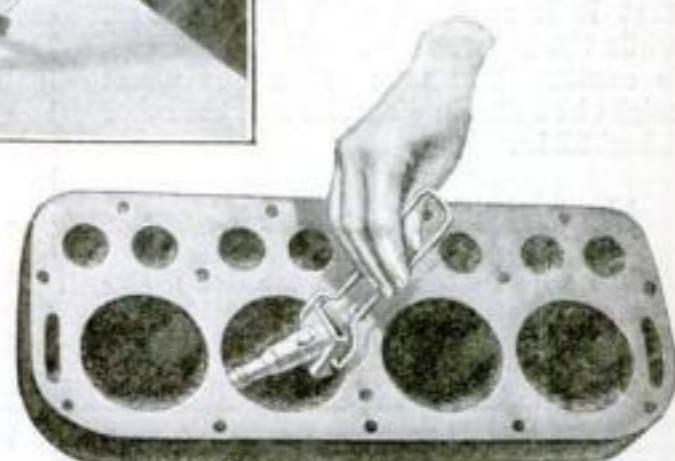
A new thief-proof tire holder consists of a disk with three radial sliding arms that push outward to engage the rims of the tires by a centrally pivoted lever with an eccentric cam. A series of holes along the rim of the disk make it possible to padlock the handle of the lever when the jaws have a firm hold on the tires



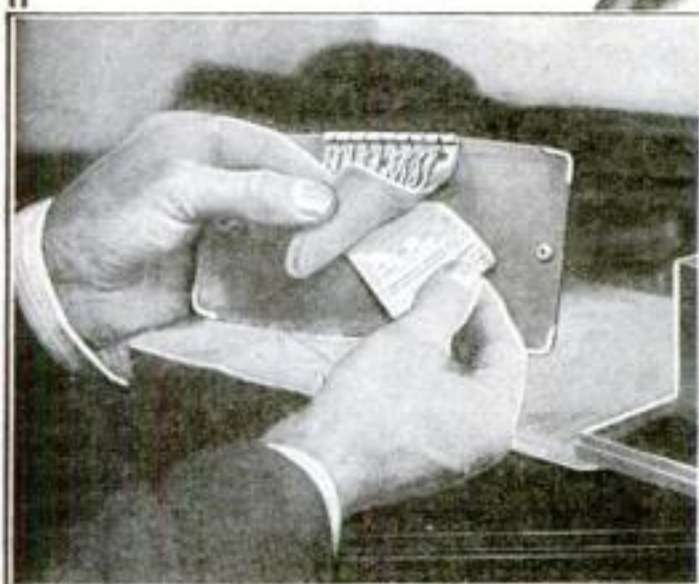
A combination lamp and reflector forms a unit that fits into the headlight socket without interfering with the dimmer



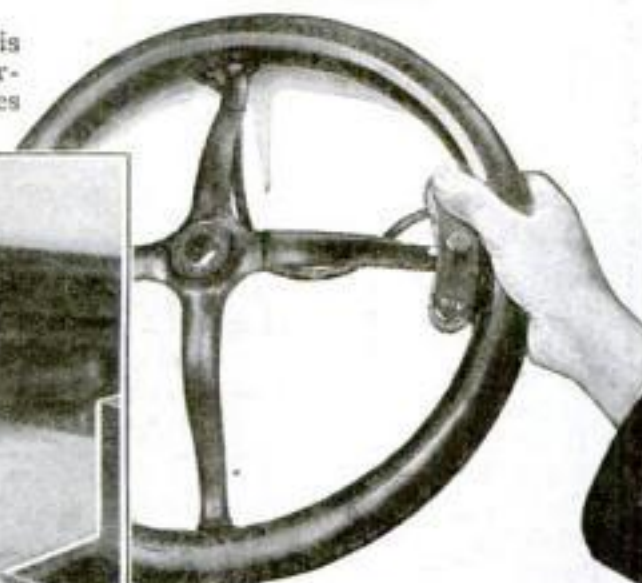
This carbon brush with wire bristles is a useful accessory for removing carbon deposits from corners and curves



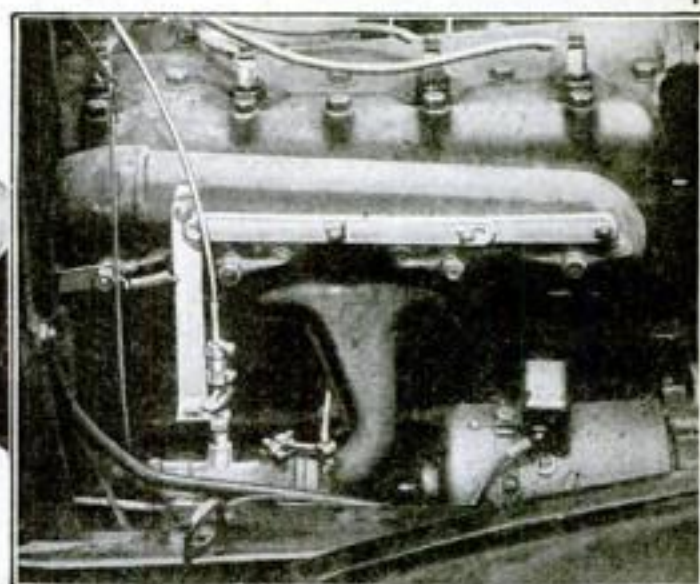
The method of using a recently invented gage for measuring the inside diameter of automobile engine cylinders is shown above



This combination key case and automobile license pocket recently placed in the market will hold from one to 16 keys



Pressing one end of this control lever starts the lights; pressing the other, dims the lights. The horn button is in the center



Installed on a Ford carburetor, this regulator modifies carburetor setting as temperature of the exhaust manifold changes

(Continued from page 74)

This condition is not only hard on tires, but dangerous. You will conserve your tires by using the brakes as little as possible. Reducing speed by coasting is better than braking, as you will learn by observation.

Intermittently slipping the wheels of your car by ascending a rough incline at full speed in second or low gear is very hard on tires as well as on the entire car mechanism.

Make sure that the front wheels are always in alignment, otherwise they will cause excessive tire wear. Springs that are too flexible or too stiff will cause additional tire wear.

Know Your Car

ONE way to know your car and run it economically is to have a good automobile reference book at hand.

Supplementing the regular articles in *POPULAR SCIENCE MONTHLY*, some of the best books, both for the average car owner and for the garage proprietor or mechanic, are the following:

The new (thirteenth) edition of Dyke's "Automobile and Gasoline Engine Encyclopedia" (Goodhardt-Wilcox Co., Chicago), which covers every phase of the construction, principle of operation, care and repair of automobiles, motor trucks, tractors, motorcycles, motor boat and stationary engines.

"The Modern Gasoline Automobile" and "Automobile Repairing Made Easy," both by Victor H. Page, and published by the Norman W. Henley Co., New York.

"The Gasoline Automobile," by Hobbs and Elliott, McGraw-Hill Book Co., New York.

Undersized tires are poor economy. On a certain car the tire mileage was increased from 5600 to 9600 by adding half an inch to the tire size.

A new tire should always be equipped with a new tube—such a combination is likely to give 10,000 to 15,000 miles without any trouble, whereas a half worn tube gives out when least expected.

And most important, inflation of the tires should receive the most careful attention. Don't guess at their pressure, but use a tire gage. If you buy good tires, you can surely cut your tire bill in half by keeping them properly inflated.

What Causes Differential Noises?

MOST automobile drivers have observed that differential noises are periodic. For several months, perhaps, a well-oiled housing will develop a roaring noise that can not be located; then suddenly, for some unknown reason, the noise will cease. Later the roaring may develop again. This mysterious irregularity baffles most amateurs and many professionals.

By R. A. Houston



It pays to look after the rear tires

In most cases the noise is caused by an inequality in the diameters of the two rear wheels. A heavily treaded cord tire can easily lose an inch of rubber from the tread and still be serviceable, but this loss reduces the diameter of the wheel two inches. Suppose that one of two 32-in. tires becomes so badly worn that it is replaced with a new shoe, while the other, also considerably worn, is continued in use; then one wheel might be 30 in. in diameter and the other wheel 32 in.

Unequal Tires Is One Cause

The wheel having the smaller diameter would also have the smaller circumference, and in traveling a mile the 30-in.

wheel would make 672 revolutions while the larger wheel would make only 630 revolutions. The smaller wheel would make 42 revolutions a mile more than the wheel with the new shoe.

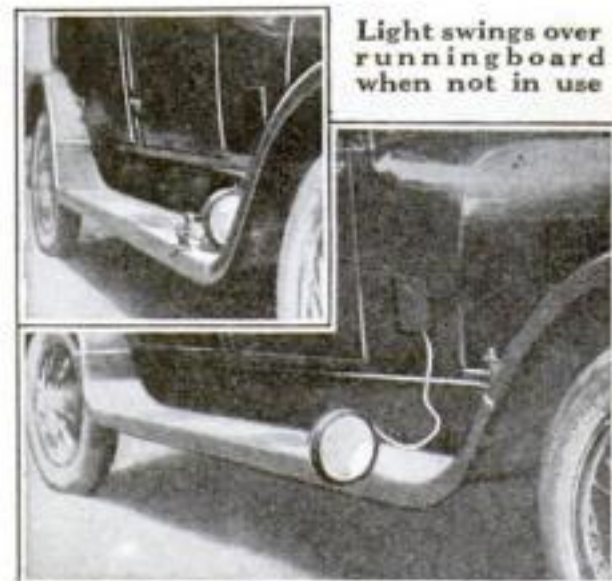
This condition calls into constant action the small pinion gears in the differential. There are three of these gears and they carry the full load of the car, but they are supposed to work only when turning corners. When these small gears, under enormous load, are called on to function continually, they soon wear, and since each of them makes several revolutions to one revolution of the wheel, the three worn gears combined produce the growling noise that comes from the differential housing. If the rear axle emits this sort of noise, look first to the tires. The trouble may be entirely with them.

Inflation also has considerable effect, because an under inflated tire may easily be 2 or 2½ in. smaller than its companion tire.

A little time spent in keeping tires correctly inflated may save a tire bill and a new differential assembly.

Runningboard Spotlight Aids Night Driving

AUTOMOBILE tourists and those who drive frequently on country roads at night will find a searchlight mounted on the right-hand runningboard of the car, as



Light swings over runningboard when not in use

shown, a great help in staying on the road. It lights up the margin of the road and shows where the ditch lies. When not in use, it is swung in over the runningboard.—B. W. REID, Cincinnati, Ohio.

IN SEEKING the cause of rattling noises about your car, examine in turn the fenders, brakes, hood fasteners, lamps, doors, and springs.—F. B. J.

Homemade Separator Filters Sediment from Gasoline

By Howard Greene

A GASOLINE separator that will remove both sediment and water, can be made easily by following directions and illustration below.

No dimensions are given, because the size of the separator will depend entirely upon the size of the engine. The body of the separator should have a capacity equal to about twice that of the carburetor bowl.

The pipe caps at top and bottom are drilled for the nipple at the top and the sediment cock at the bottom. The big end of the enlarging nipple is fitted with a gauze screen; this is in two layers, soldered together and soldered to the end of the nipple.

All the joints must be well made, for gasoline will leak through where water will not. It is much better to use brass pipe and fittings. If the gasoline used is more than ordinarily dirty, put an extra screen midway between the bottom of the enlarging nipple and the lead-in pipe. The separator can be drained by means of the sediment cock and the gasoline drawn off for priming and cleaning.

Once in a while the whole separator should be thoroughly cleaned by disconnecting the gasoline lead-in and unscrewing the body from the top cap.

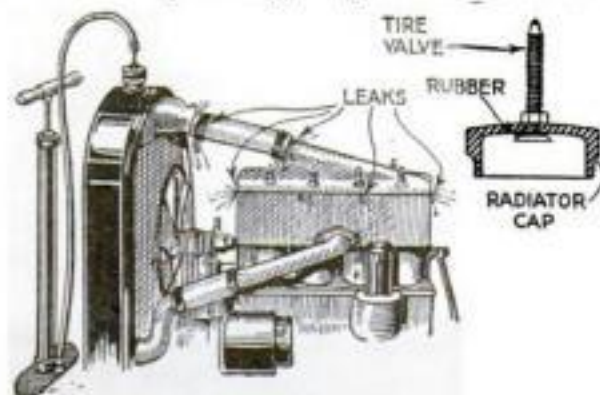
Testing the Auto's Circulation System

LEAKAGE at pump stuffing

By G. A. Luers

boxes and hose connections, which will open up when the car is operating on the road, often are not in evidence when the machine is stationary, and it is difficult to determine where the leaks are unless pressure is applied to the motor. If that can be done, the leaks will show up plainly.

To apply the necessary pressure, it is necessary merely to modify a radiator cap by the addition of a tire valve,



How air pressure makes leaks visible

as shown. With this in place, pump about 5 lbs. of air pressure into the circulation system. It is obvious that a rubber gasket should be placed under the cap and a cork in the overflow pipe.

The same device is useful when flushing the radiator or using a scale remover, because the pressure aids materially in forcing the scale and muck out through the drain.

When the location of a leak is known, it can usually be repaired easily.

Neat Striping Adds Final Touch to Repainted Car

EVEN the most careful job of repainting a car sometimes lacks a finished appearance because it has no striping. To add the stripes, the colors desired should be mixed to a rather stiff consistency. They should be thin enough to flow readily



How the brush is held

from the brush and yet be stiff enough to stay where put. A 10-cent water-color brush will do the work.

After the lines have been traced with white chalk or snapped on with a chalk line, the painter sets his cups of paint

and turpentine on the side of an old varnish can and rests one end against the car to steady it. Then he dips the brush and carefully follows the chalked line, steadying his hand with his middle finger.

It is not as difficult as it looks and if a mistake is made, the line can be removed with turpentine and a rag and, when dry, gone over again.—DALE R. VAN HORN.

Hot Brick Starts Cold Motor

A SIMPLE expedient for starting a cold motor is to heat a common building brick in a stove or furnace and place it beside the carburetor. The heat radiated from the brick is sufficient to warm the manifold so that starting is possible.

The brick is carried in the engine pan and when a stove or furnace is not available, it is heated by pouring gasoline over it and lighting it. This provides a roadside method of getting a start regardless of the temperature.—F. J. E.



The Home Workshop

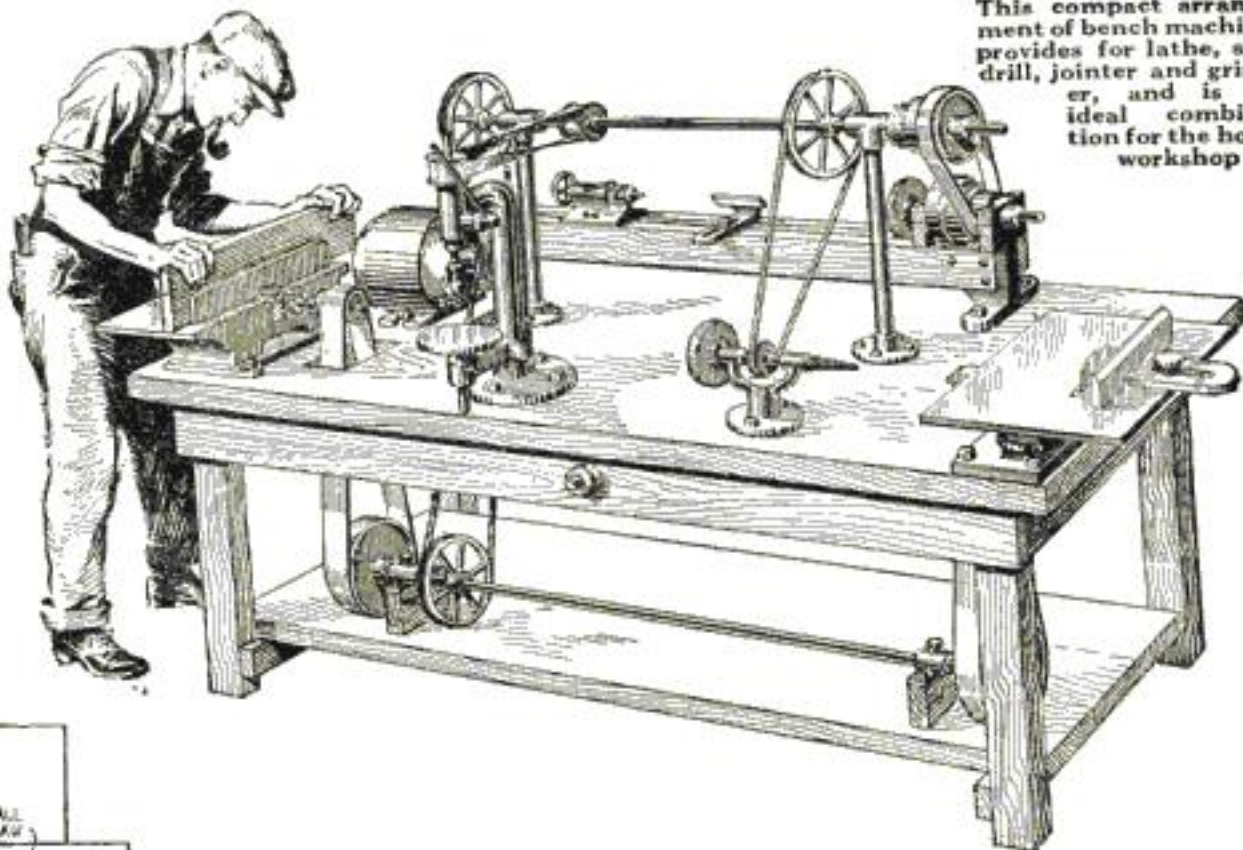
New and Useful Things to Make with Tools

How to Motorize Your Home Workshop

By Robert S. Lewis

JUST as machines have taken much of the drudgery from large shops, cheap electric power and sturdy and inexpensive small motors make it possible to eliminate tedious hand work from the home workshop. By motorizing his shop, the home worker can quickly repay the cost of installation through increased production and better and more accurate work.

The first point to be considered is the power needs of the largest and heaviest machine to be used. This will fix the size of the motor, since only one machine will be in operation at one time in the shop. Motors of $\frac{1}{4}$ hp. can be bought for \$20 or less, sometimes considerably less, and they will drive almost any small machine. For the handy man and for a farm workshop,



This compact arrangement of bench machines provides for lathe, saw, drill, jointer and grinder, and is an ideal combination for the home workshop.

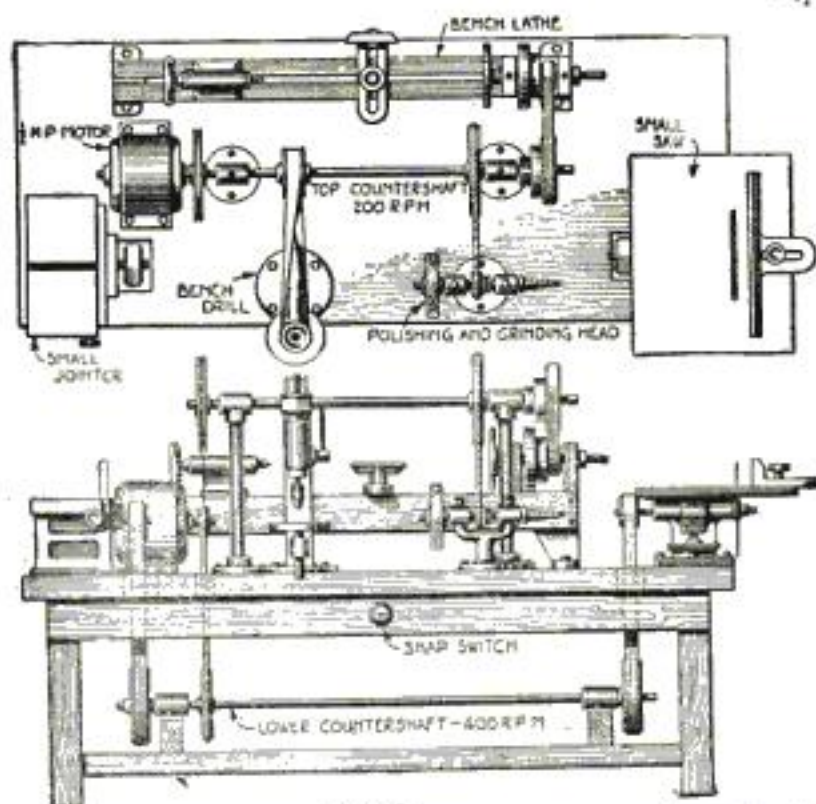


Fig. 1

where heavier work is done with floor type machinery, the motor must be at least from $\frac{1}{2}$ to 1 hp.

Almost all types of hand or foot operated machinery can readily be converted into power machines by removing the cranks and levers and placing pulleys of suitable diameter on their shafts. Pulleys and shafting are relatively cheap, but if the builder wishes to cut down expenses to a minimum, he can make the pulleys of wood, iron, and other available materials.

For small bench machines, the usual plan is to centralize the motor and group the machines around the edges of the workbench. In this manner one or, at most, two shafts will suffice. Most of the $\frac{1}{4}$ -hp. motors have a speed of 1750 r.p.m. This is reduced at the first countershaft to around 400 r.p.m., and is further reduced to about 200 on the second shaft. From these two speeds each type of machine can readily be belted up to the correct speed. Drill presses and woodworking machinery oper-

ate on the high speed shaft and small lathes and milling machines on the low speed shaft.

Small countershaft hangers and supports are readily made of standard pipe fittings, as shown. The base of the hangers are floor flanges into which are screwed lengths of pipe to serve as uprights. To these are fastened pipe tees, which are converted into bearings by pouring Babbitt metal into them after the shaft is properly aligned and the lower opening plugged with paper, clay, asbestos or other substance to

prevent the babbitt from filling the pipe. Cardboard disks are cut and slipped over the shaft and clamped in place to form dams for holding the babbitt in place.

The pouring is done through a $\frac{3}{8}$ -in. hole drilled in the top of the tee, and later an oil hole is drilled through the same place. To prevent the babbitt from sticking to the shaft, cover the shaft with thin tissue paper, the paper first being well soaped.

The installation illustrated in Fig. 1 is a good one for the woodworker's shop. The shafting arrangement is such that one short shaft reaches all the small tools, while the long shaft, beneath the bench, takes care of the bench saw and jointer. The drive from the motor to both shafts is vertical, the power being applied only to one shaft at a time. The different shaft speeds are obtained by using a pulley twice as large on one shaft as on the other.

When two shafts are placed on top of the bench, a number of different speeds are possible, and, if desired, the more important machines can be equipped with a tight and loose

(Continued on page 117)

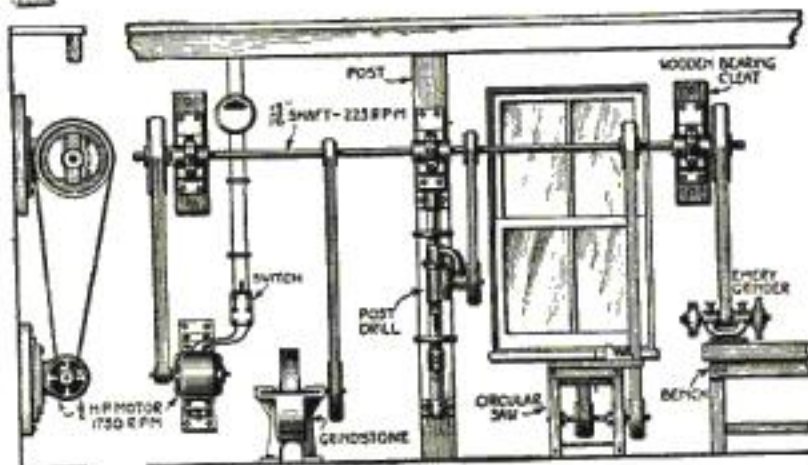


Fig. 2

Figure 1 at the upper left shows a woodworker's bench with motor and two countershafts for driving five small machines. Figure 2, above, is a general utility workshop with heavier machines, especially useful on the farm. Figure 3, at the right, is a space saving plan for the home machinist's bench.

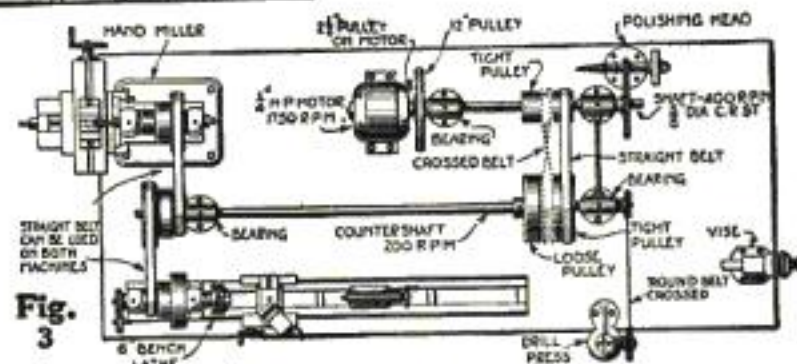


Fig. 3

The Secrets of Successful Stenciling

By P. A. Daschke

TO BE able to design and apply stencils is a most valuable accomplishment for the home worker, and one worth mastering. Stencils can be used for ornamenting many kinds of painted, enameled, and stained work, and will serve alike for decorating small pieces of furniture and large plaster or wallboard surfaces. There is nothing difficult about the process and the only precautions necessary are to choose appropriate designs and harmonious



stenciling, and the spaces are as much a part of the design as lead binding on art glass is part of its artistic effect. This is illustrated at G, where the fret is given the appearance of being mitered at the corners; at E, which resembles a mosaic setting, and at F, which shows a continuous running figure, the ties forming a background setting like mosaic or inlaid work. In this way may be prepared all sorts of artistic
(Continued on page 122)

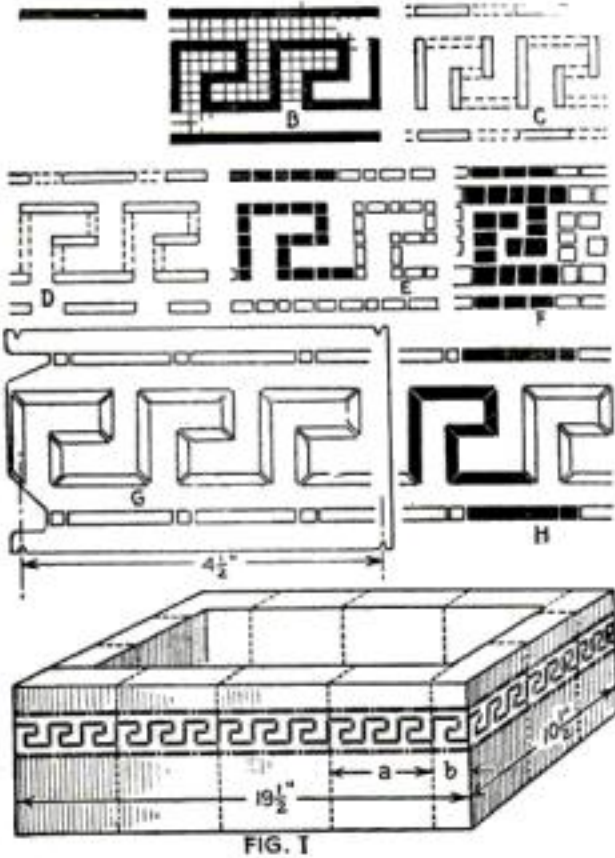


FIG. 1
Easily cut straight-line borders offer endless possibilities for the home decorator

colors and so avoid the cheap effect that indiscriminate or over elaborate use of stenciling is apt to create.

The simplest stencil element is a straight line A, Fig. 1. Simple Greek fret borders and other line designs, B, are easily drawn by ruling the paper into small squares or using cross-sectioned paper, which may be obtained at any stationery or art store. To stencil a continuous running design of this kind, it is necessary to cut two stencils in such a manner that the lines overlap by one square, so as not to leave any gaps, as at C and D.

The usual practice is to cut only one stencil and leave spaces or ties to be filled in later. The proper way is either to overlap stencils or to have the ties form part of the ornament, so that no filling in with a brush is necessary. The latter is the true art of



Wall patterns and gold stencil for a mahogany table
FIG. 2

Wind and Wheel Drive This Speedy Ice Bicycle

By George A. Luers

THRILLING and yet comparatively safe is the new winter sport of bicycling on the ice. The machine is equipped with skis and a jibsail, so that it is really a high speed scooter.

Three or four machines make possible 10- or 20-mile races around a one-mile circular track. There is just enough pedaling to keep the rider from being cold without the necessity for sufficient exertion to tire him. Although the scooter is intended for use on ice, the skis will support it on hard packed snow roads and will allow a speed of from 15 to 20 miles an hour; but more effort has to be put in the pedaling.

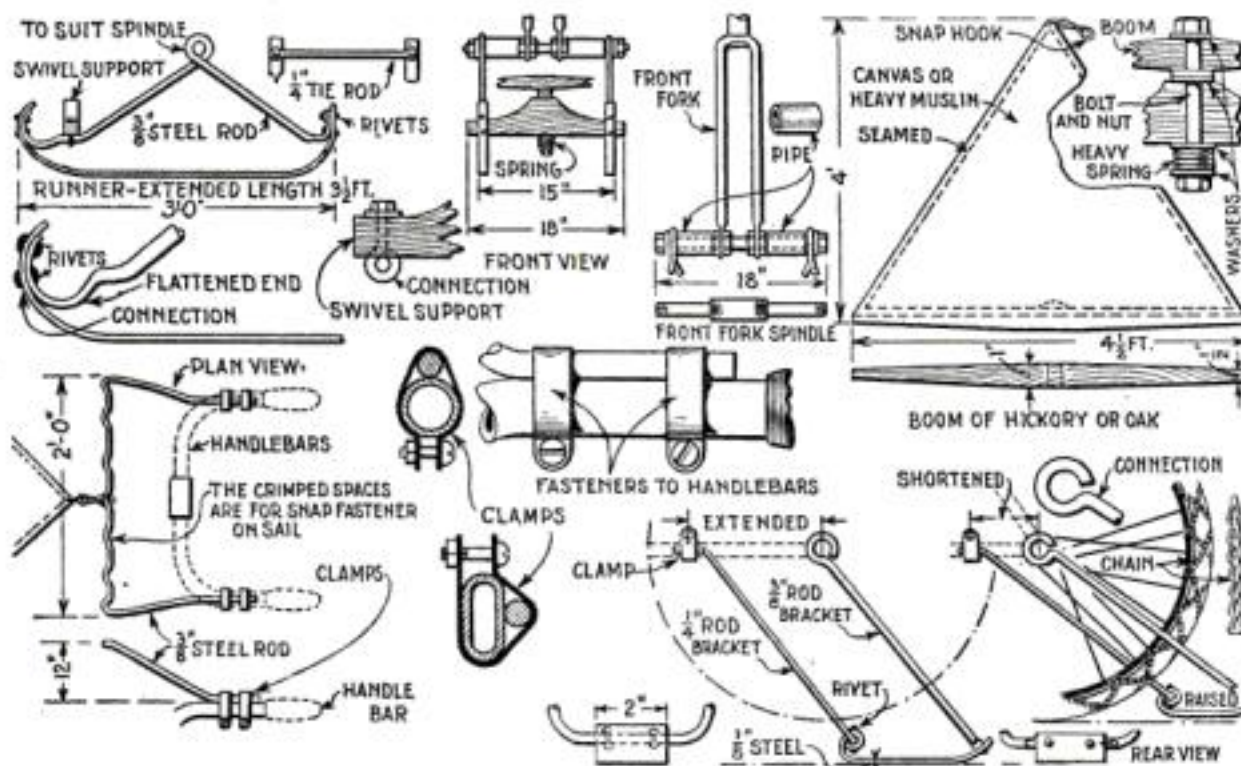
No cutting or disfiguring of the wheel is required in the construction of the scooter. In place of the front wheel, two parallel skis are attached by means of a center bar to the front forks and are controlled through the handlebars for steering. These skis or runners are $\frac{3}{4}$ by $\frac{3}{16}$ in. steel strips, $3\frac{1}{2}$ ft. long; the braces are $\frac{3}{8}$ -in. steel rods. A wooden cross member on the forward end supports the jib sail boom. The sail is triangular, $4\frac{1}{2}$ ft. wide on the bottom and 4 ft. high. The boom is hickory or other hard wood $4\frac{1}{2}$ ft. long and tapers

from 1 in. in diameter at center to $\frac{1}{2}$ in. at the ends.

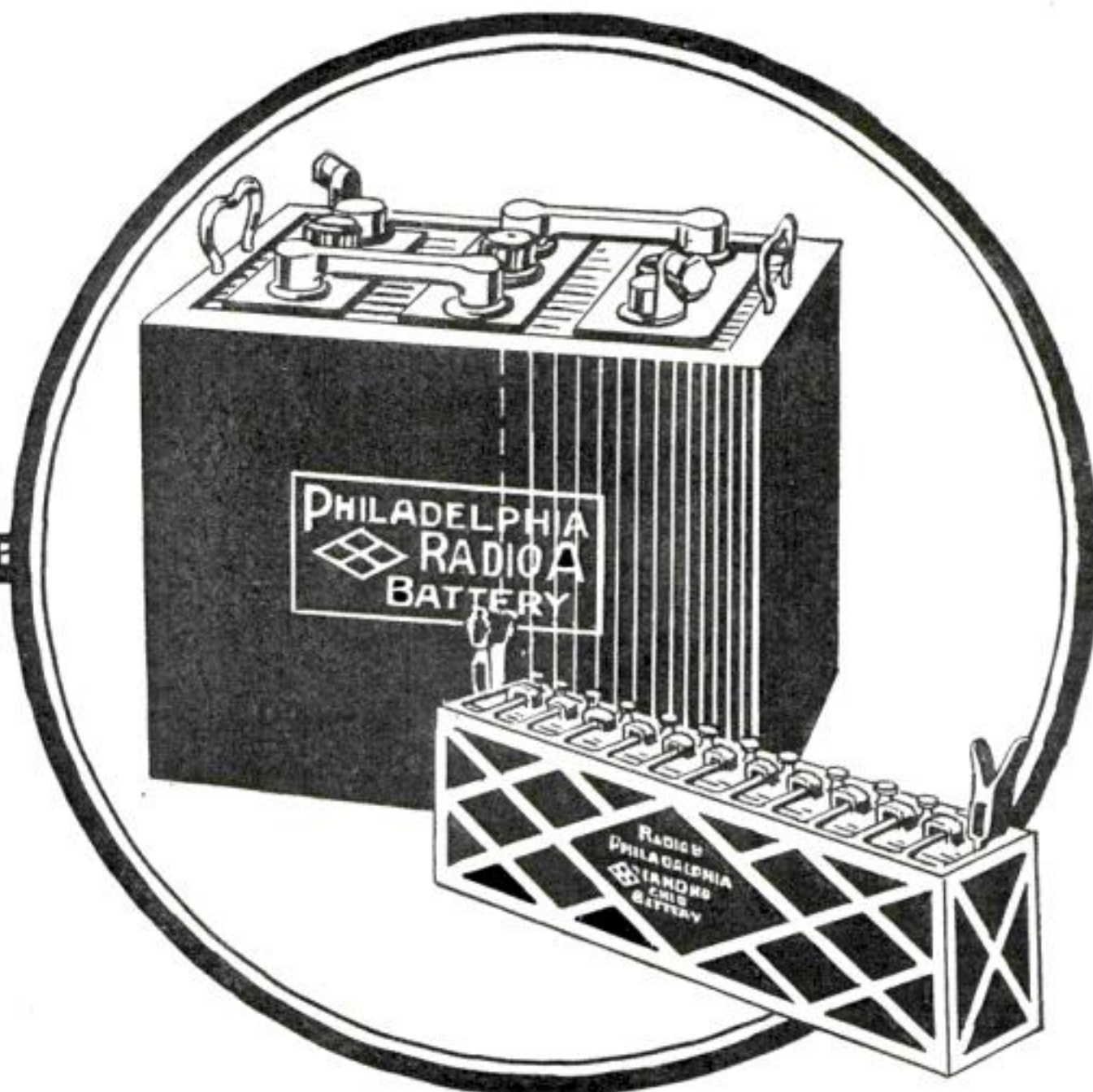
The material for the sail is either canvas or closely woven muslin. A crimped wire span above the handlebars provides several places for attaching the top of the sail with a snap hook. The sail can readily be furled when the scooter is to be pedaled against the wind. The swivel joint of the boom at the skis is stiff, but will move at a tug on the sail.

The rear ski or runner is a light bearing skid, which may be adjusted so as to be only a fraction of an inch above the wheel. This supplementary runner is for use on snow and prevents the wheel dropping below the surface; so that it also steadies the traveler's position when riding across ruts and tracks.

If desired, this runner may be adjusted so that the rear wheel is clear of the ice, as shown in the illustration, somewhat exaggerated for the sake of clearness. The scooter then depends entirely upon wind and sail for propulsion. The attachment is somewhat like a bicycle stand and is secured at the rear hub. The tie bars are $\frac{1}{4}$ -in. steel rods with simple clamps to allow ad-
(Continued on page 121)



The parts of the scooter attachment and how they are added to the bicycle frame



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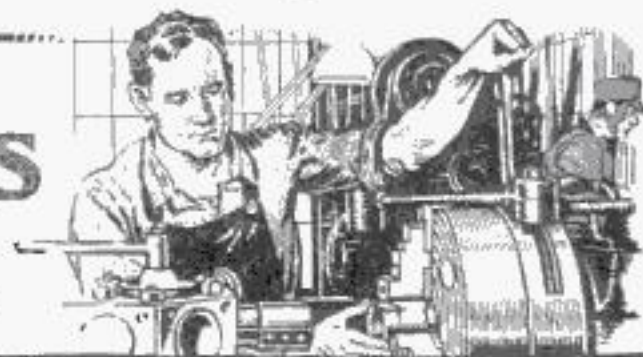
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How Expert Mechanics Save Time and Labor



Making Accurate Measurements with Simple Tools

By Joe V. Romig

OF ALL factors that determine the success or failure of the mechanic, especially the machinist, that of accurate measurements is the most important. In large manufacturing plants, where interchangeable parts are produced, the demand for accuracy is met largely in the toolroom by expert design and workmanship in jigs, fixtures, and gages and ordinary methods of measuring are scrapped almost entirely. But, in the jobbing shop and the experimental department, where it does not pay to make gages for a single job or for a few pieces, accuracy in measuring finished surfaces depends upon the skill of the individual workman.

The difference between good and bad measurement is often simply a matter of common sense. Even very common tools will give surprisingly good results if properly handled.

A friend of mine is an inspector for a large machine tool company that sublets quite a bit of heavy work. He goes to the various plants working on the contracts and inspects the finished product before it is shipped. His tools for this important work



each has his individual opinion of the proper amount of the line or graduation to include when setting his calipers or of the proper lightness or heaviness of their touch.

When plain calipers are used, often they are set either too tight or too large because the workman does not take pains to look squarely at the scale from a point precisely opposite the mark at which the tool is to be set.

To set calipers to a close degree of accuracy, a magnifying glass should be used. The simple attachment illustrated is designed to slide on a 6- or 12-in. steel rule. It is of thin brass, the glass being mounted over the pointer at the proper focal distance. The attachment is held in place by the lower spring so that it may be moved readily and yet will remain wherever set.

Leg and Micrometer Calipers

Even then, with a properly set caliper, the difference of the individual touch of the mechanic in applying the tool to the work will cause a variation in the measurements. To measure with an outside caliper, one foot should be held against the lower surface of the work, while the other foot is passed over the top, swinging or vibrating sideways, in order to locate the point directly opposite. When the foot will vibrate about 1/16 in. with a light scratchy feeling, the touch is correct. Likewise, on inside measuring with calipers, the feet should touch in the same manner.

Micrometers, particularly those with ratchet stops, give far more uniform results in measuring, and the individual variation of touch is reduced to a minimum. This is due partly to the flat, parallel faces of the anvil and spindle ends, with their large contact on the surface of the work.

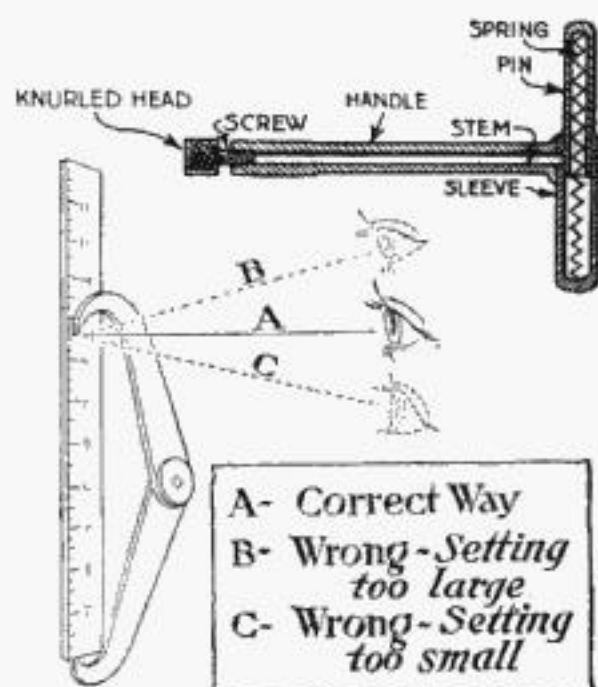
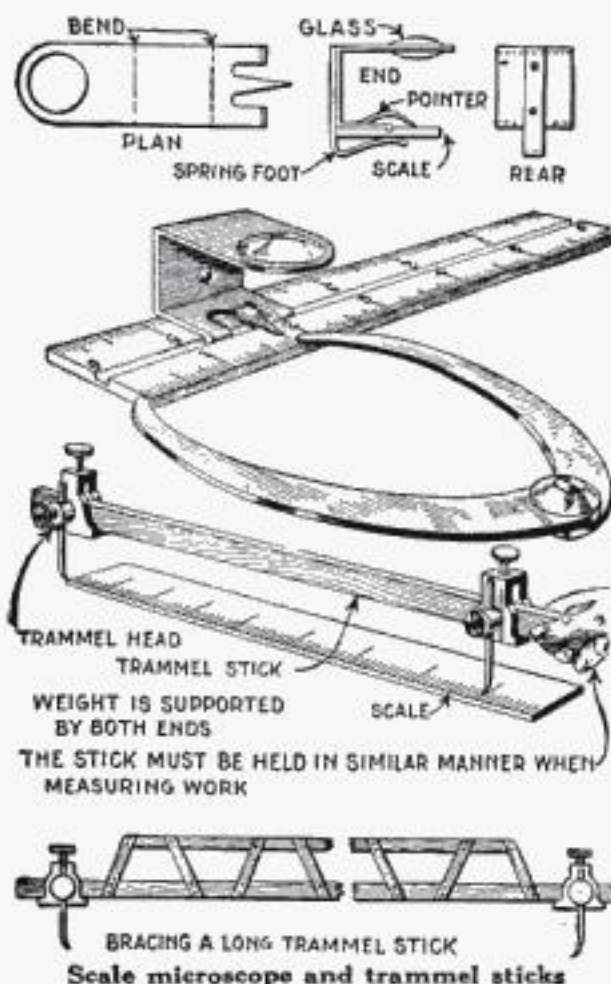
A handy tool for the machinist in measuring bores, which will give better results than a pair of inside leg calipers, is the inexpensive telescopic pin gage illustrated. When used in conjunction with an outside

micrometer, it measures with the exactness of an inside micrometer. The smallest tool of this kind has a range of 1/2 to 3/4 in. and the largest from 3 1/2 to 6 in., with intermediate sizes between.

Many errors in measurement are made through the carelessness of the machinist in handling his trammel stick. Trammels should be held alike when setting and measuring; that is, the support should be in the same place, as any shifting of the position of support will surely spring the beam and give a false reading.

For measuring on heavy work, the handiest thing of all is the steel tape line. If not guaranteed accurate by the manufacturer, this should be checked against an accurate scale by laying the tape on a 4- or 5-ft. scale and comparing the graduations with a microscope. Stretched tightly across the bore of a large casting, or to the opposite sides of a flange, the tape will give accurate readings directly.

For the measuring of large outside diameters, the tape line is used on the circumference which, being a little more than three



Telescopic pin gage (above). Setting calipers (below)

times the diameter, will reduce any error to one third.

As the graduations of the tape line must be placed outwardly when measuring the circumference, it stands to reason that an allowance must be made for the thickness of the tape line itself. In other words, the circumference shown on the tape line is divided by 3.1416 and from that is subtracted twice the thickness of the tape.

It is worth while for the mechanic to increase his assortment of measuring tools whenever possible in order to have the assurance that he can handle any measuring job brought to him. Besides the usual outside and inside micrometers, there are many special calipers, scales, scale holders and gages.

consist of a pair of 8-in. inside and a pair of 8-in. outside calipers, 12-in., 6-in., and 3-in. steel rules, and a reliable 50-ft. steel tape line. Of these, the tape line is used the most. His methods are simplicity itself and I have seen him check up the squareness of two right-angle faces with a tape line, using the time-honored 6-8-10 rule.

Ordinarily, if all of John's work can be expected to be a trifle large and if all of Jim's tends to be small, the reason is that

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Turkey	3½	1½	2¼	1	2½	¾	2 & 4
Geese	3½	1½	2¼	1	2½	¾	4 in Flight Over deep
Brant	3½	1½	2¼	1	2½	¾	
Large Ducks	3½	1½	2¼	1	2½	¾	6
Medium Ducks	3½	1½	2¼	1	2½	¾	6
Grouse	3	1	2½	1	2½	¾	6
Prairie Chicken	3	1	2½	1	2½	¾	6
Squirrels	3	1	2½	1	2½	¾	6
Rabbits	3	1	2½	1	2½	¾	6
Small Ducks	3	1	2½	1	2½	¾	6
Pheasants	3	1	2½	1	2½	¾	6
Pigeons	3	1	2½	1	2½	¾	6
Doves	3	1	2½	1	2½	¾	6
Quail	3	1	2½	1	2½	¾	6
Snipe	3	1	2½	1	2½	¾	6
Woodcock	3	1	2½	1	2½	¾	6
Shore Birds	3	1	2½	1	2½	¾	6
Reed Birds	3	1	2½	1	2½	¾	6
Trapshooting	3	1	2½	1	2½	¾	6

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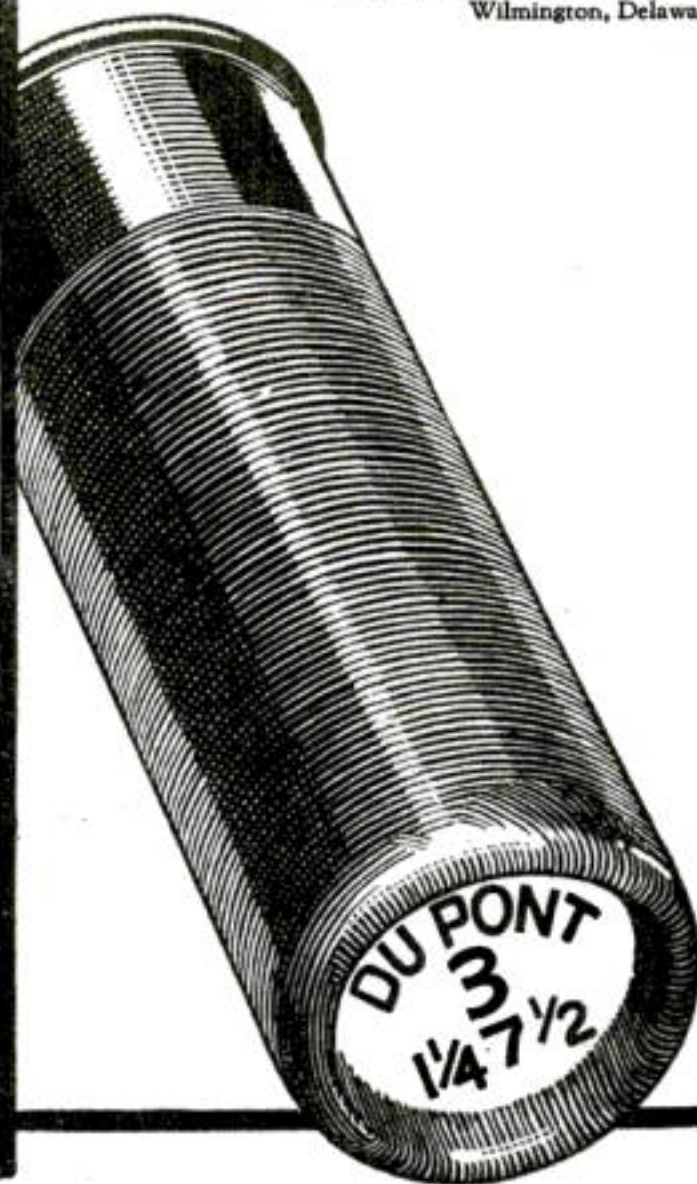
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BETTER SHOP METHODS

Nested Steel Trestles Sustain Heavy Overloading

TWO advantages distinguish the type of trestle illustrated from those usually seen in shops where heavy loads have to be supported. The legs are so spaced that they are not opposite each other and the trestles therefore will nest together. This

STEEL PLATES RIVETED TOGETHER



The trestles can be crowded together for storage or holding heavy weights

permits many trestles to be stored away in a corner of the shop or in a truck for transportation.

An even more important feature is that these trestles, which were devised for use in structural steel fabricating plants, will sustain enormous loading when they are placed close together.

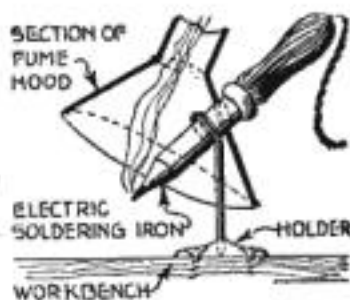
The trestles are steel plate riveted in sections, although wood can be used.—E. S.

Holding the Soldering Iron

IN A certain plant manufacturing cream separators there is considerable soldering to be done, and to speed up the work the scheme illustrated was devised. Its simplicity is its chief advantage.

The gas heated iron formerly used was discarded and an electric iron substituted. Instead of the worker holding the iron, an iron stand was fastened to the bench at the proper angle. This allowed the operator to use both hands. A hood was placed over the iron to carry off the soldering fumes.

Much better work is possible by this method, which can be adapted for use in many cases where much soldering is to be done.—J. H. MOORE.



Locking Jigs and Fixtures

ON JIG and fixture work I often use the quick acting nut illustrated. It is a great time saver and does not take as long to make as many another locking device. To tighten or loosen this nut, it is neces-



A quick-acting nut

sary to give it only a quarter turn and it then can be lifted off. This saves the time of unscrewing.

Both the screw and the nut are cut away. The lead or pitch of screw thread should be coarse and both screw and nut should be hardened if the clamping device is to be put to much use.—H. P. BOETTCHER.

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SUPPOSE that raw rubber, taken from the initial softening vats was judged for pliability entirely by its "feeling" instead of the workmen's knowledge that the time of soaking and the water temperature was correct! Suppose that after passing through washing mills and rollers it was taken from the drying rooms when the men "judged" it was dry enough—instead of the time and temperature being exactly regulated! Suppose the result of the great kneading mills was guessed by feeling, instead of further exact heat control. Or that vulcanization—that all important process—had accurate heat control left out and the elasticity or hardness of the vulcanized product had to be judged by sense of touch alone!

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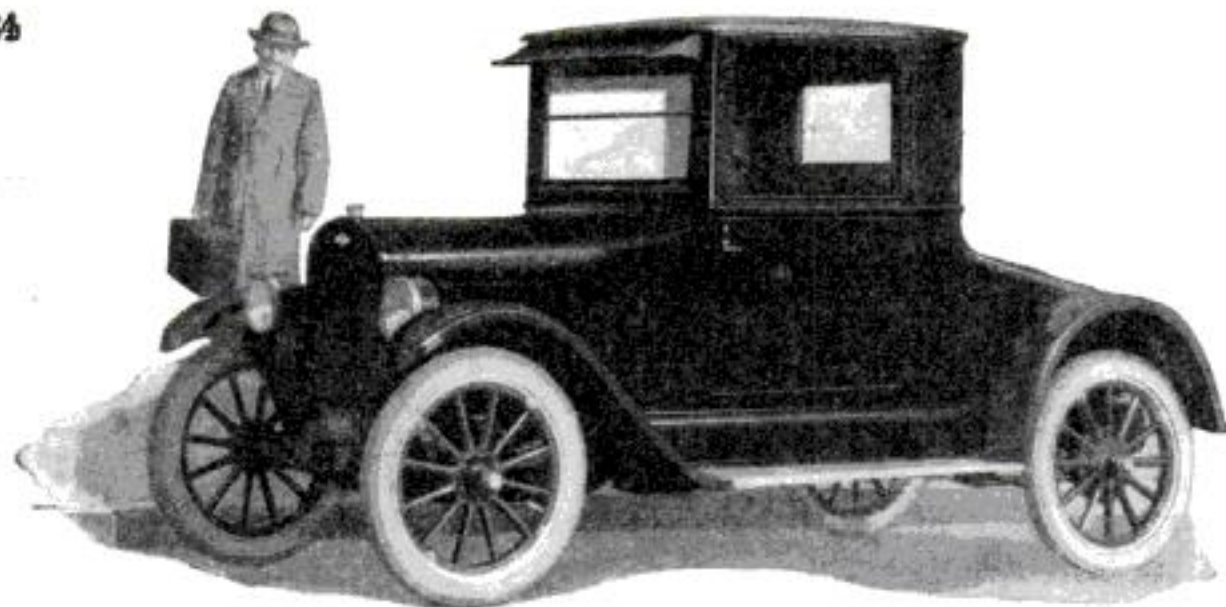
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THE HOME WORKSHOP

"How I Got that Better Job" Contest

FOR the three best contributions or letters on the subject, "How I Got that Better Job," POPULAR SCIENCE MONTHLY is offering a first prize of \$30, a second prize of \$20, and a third prize of \$10.

Each contribution should be a first person narrative of shop experience that may help or stimulate mechanics to achieve better workmanship through improved methods or the application of novel ideas. Pencil drawings should be made to explain any obscure points, and if photographs are available to illustrate any phase of the article, they also should be included. Contributions may be any length up to 3000 words. They must be submitted on or before February 20, 1923.

An idea of the sort of article desired can be obtained by reading "How Do You Grind Your Tools?" by Joe V. Romig, on page 80 of the January POPULAR SCIENCE MONTHLY.

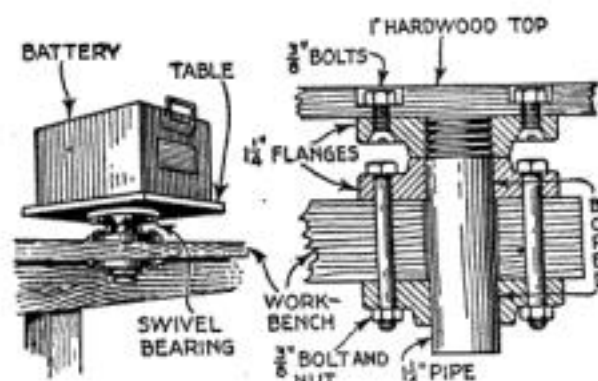
The contest will be judged by the Board of Editors of this magazine, and announcement of the prize-winners will be made in the May issue.

Address contributions to Editor, Better Shop Methods, POPULAR SCIENCE MONTHLY, 225 West 39th Street, New York.

Battery Repair Table Revolves on Repairman's Bench

A REVOLVING table is a useful addition to the battery repairman's bench. By being able to turn the battery in any position, the repair work is considerably simplified, especially such operations as soldering terminals and "pitching" shut the jars.

A hardwood board is cut a trifle larger than the outside dimensions of the batteries



The revolving table and details of swivel support

ordinarily handled, and is mounted on a 1 1/4-in. pipe flange. The 3/8-in. nuts of the stove bolts, which connect the two, are let into the surface. The base consists of two other flanges, the threads of which have been bored out to a sliding fit over the 1 1/4-in. pipe that forms the standard of the revolving table. One of these flanges is mounted above and the other beneath the top and the two are bolted in position with long 3/8-in. bolts.—E. L. F.

WORK that has been held in a magnetic chuck usually retains some of the magnetism. If no demagnetizer is at hand, and the character of the work will permit, a sharp blow on the floor will serve to remove the magnetism.

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Many who were unconvinced and skeptical have tried Coué's methods at first as an experiment. Then, conscious of its good effects upon their physical and mental well-being, they have persisted in their efforts and gained complete freedom from many ills and disorders which had been troubling them for a long time. The letters printed here are from people who had been greatly helped by this book and who have insisted upon expressing their appreciation and joy. These are only a few from the scores that have come to us unsolicited.

Why Coué Wrote This Book

Crowds of people daily besiege Coué's home in Nancy, France, where he gives free treatment to all. But, realizing that he could expect to see personally only a comparative few of the millions all over the world, who can be helped by his methods, Coué has, at our request, with infinite care written out in detail his complete instructions, showing just how anyone can apply his methods for regaining or preserving health. The remarkable quality of these instructions, upon which everyone comments, is the fact that they are so plainly given that one reading gives a complete understanding of his method and opens the door to a new life for thousands of people. **THERE IS LITERALLY NO MAN OR WOMAN LIVING THAT THIS BOOK CANNOT HELP.**

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"Words cannot explain my happiness and joy. The doctors have been wanting to operate on me for nine years for a growth in the neck of my bladder. . . . after receiving Emile Coué's book and applying his method, all the inflammation is gone and the growth is also going away. I was having serious trouble with my eyes, which has also almost gone." **Mrs. A. B. C., Quincy, Ill.**

"For years I had a spinal curvature and I had given up hope of a cure, two or three bones being misplaced, making a hollow in the back. I hardly know how to explain it. I am very thankful to Dr. Coué to find that my spine is straightening and the hollow has filled out." **Mrs. F. C. D., Poplar Hill, Md.**

"I have had an almost complete healing from a chest pain that for years has given me the most terrible suffering—almost a death agony—when ever I would go up steps or walk hurriedly. I began to use the mental suggestion of the great scientist, Dr. Coué, as soon as your book came to me." **Mrs. C. H. W., Mansfield, O.**

"Emile Coué's method is the most effective of any I have tried. In its simplicity it works wonders. I cannot begin to express the torture of my body and mind which I suffered. Now, I am happy to say I am well and at peace." **Mrs. J. D. T., Charleston, W. Va.**

"Emile Coué's book has meant to me a source of inspiration, a living fountain of Light and Life." **Mr. L. J. F., Pittsburgh, Pa.**

"It is the most remarkable and wonderful book I know of. It has not only cured my many physical ills, but better still, it has given me an understanding of myself. I am deeply indebted to Dr. Coué for the knowledge of the conditions necessary to Self Mastery, for I have apparently doubled my mental and physical efficiency." **Mr. L. P. D., Lyme, Conn.**

"The benefits I have derived from this book have simply been marvellous. Before reading Dr. Coué's book I was constantly brooding and very melancholy. Now everything again seems bright and I am enjoying life as I haven't before in thirty years." **Mr. H. G. S., Oconomowoc, Wisc.**

"That little book is a revelation even to one who has spent the best part of his 77 years in psychology and it opens a new era of great possibilities." **Mr. G. J. O., Los Angeles, Cal.**

"Emile Coué's book is a godsend to suffering humanity, especially for nervous people. I have cured myself of worry and hurry and nerves of all kinds, until today, thanks to God and M. Coué I am a well and happy woman." **Mrs. C. A. B., Marshall, Texas.**

The remarkable effectiveness of Coué's method lies in its complete simplicity. It does not advocate any complicated system of diet, medicines, exercise, straining of the mind or forcing of the will. It reduces to simple formulas the great and powerful laws of mental action in such a way that everybody can understand and use his method with immediate results in curing bodily ills, correcting nervous disorders, strengthening character, eliminating fear and in building up in general an abundant reserve of physical and mental health.

'Autosuggestion is an instrument that all of us possess at birth. Its use as taught by Coué is based on the power of the sub-conscious mind. The sub-conscious is a force which has too long been neglected in its possibilities for physical and mental health. Physicians and others have long recognized its importance but it has remained for Coué, the modest French scientist, to simplify its principles and laws making them practical and vitally effective so that anyone can use them. Coué shows definitely how you can command the forces of the sub-conscious to work for you according to your individual requirements.

The secret of Coué's method

is just that it helps to lull the conscious mind into a drowsy state and allows the suggestion of improving health and power to sink its roots deeply into the unconscious, getting it to accept ideas of health and success. All the forces of your being will then be directed to achieving these ideas without ordeal or effort by merely with the pleasurable sensation of good work being well done.

Science has only lately discovered some of the truths about the unconscious mind. Coué stands out today as the man who has invented an ingenious method of putting its secrets at the disposal of us all. He has presented men with a new key to the inner storehouse of vast powers of vitality. The practicability of this method is being attested to by an ever increasing host of believers.

Lord Curzon, Foreign Minister of Great Britain, and Lady Beatty, foremost English hostess, were the first world prominent people to be cured by Coué. Lord Curzon suffered from a particularly serious case of insomnia of long standing, which the best physicians of England could not cure or relieve. Both of these important personages made public acknowledgements of their cures, giving Coué full credit. There are hundreds of other prominent people who have been cured by Coué but who have no wish to make the matter public.

Luther Burbank, the famous botanist, has written the following tribute, which is impressive: "Emile Coué merits our joyous admiration, universal love and immortal thanks for his wonderful emancipation proclamation contained in his book."

Dr. Frank Crane, whose famous editorials reach millions of people daily and who is one of the most important forces of public opinion, said recently: "Emile Coué helps people to get well by Autosuggestion."

Henry Ford, the hard-headed apostle of common sense, said in a recent interview: "I have read Coué's philosophy; he has the right idea."

Chauncey M. Depew says: "There is truth in the Coué gospel."

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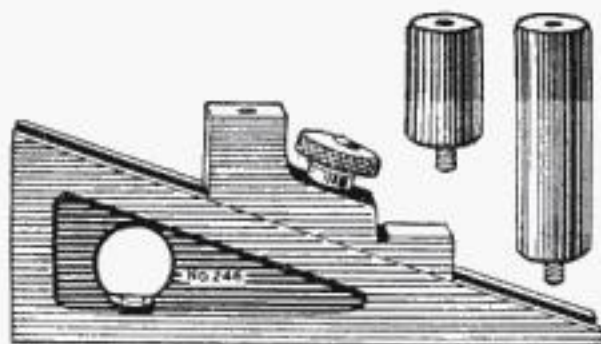
BETTER SHOP METHODS

What Tools Can You Lawfully Make?

EVERY practical tool user and all of our readers who are interested in inventions or in patents on new tools, or improvements on old tools, will find illuminating a recent experience of POPULAR SCIENCE MONTHLY.

On page 92 of our December, 1922, issue, a contributor described a planer gage with several useful features, constituting an improvement on gages of this type commonly in use. So novel a device did we believe this to be that, in the interests of our readers and at considerable expense, we prepared blueprints to facilitate the construction of the tool.

It developed later that the L. S. Starrett Company, of Athol, Mass., has a broad



A useful planer and shaper gage made by the L. S. Starrett Co. under patent No. 1,202,114

patent that not only covers the well known planer gage it manufactures, illustrated on this page, but also protects that company on any other gage of the type represented by that tool. Under the patent laws, therefore, no individual may make, even for his own use, the improved planer gage described in the article mentioned, without license from the L. S. Starrett Company.

When a patent is granted by the United States Patent Office, the drawings that form a part of it are published and may be reproduced and described by any magazine. It is not lawful, however, to make the patented article without permission from the owner of the patent.

For this reason POPULAR SCIENCE MONTHLY publishes in the Home Workshop and Better Shop Methods departments instructions for making only such devices as are not patented.

It is needless to say that POPULAR SCIENCE MONTHLY would not have published the improved planer gage design, excellent as it is, if it had known of the patent rights of the L. S. Starrett Company, and we have therefore withdrawn the offer to supply blueprints. Neither did the toolmaker who designed and made the improved gage happen to know of the existence of the Starrett patent (later called to our attention as No. 1,202,114; granted October 24, 1916, with broad claims covering such tools).

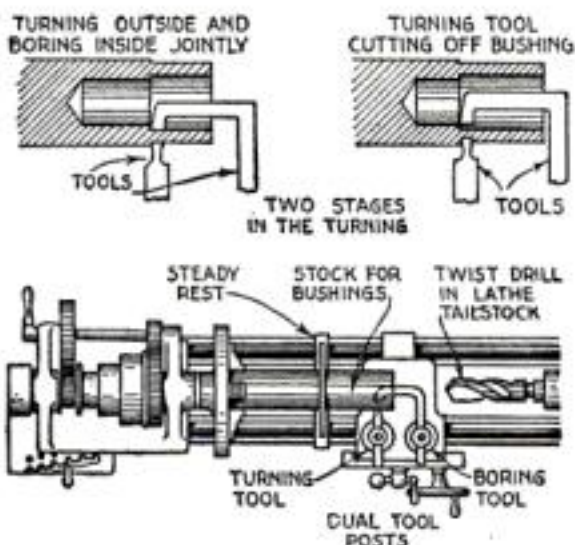
The difficulties of improving various tools and processes without infringing on the rights of owners of previous patents are obvious, but the inventor of an improvement on a patented device will generally find that reputable, established manufacturers of tools encourage new ideas and give fair treatment to those who submit such inventions to them.

It was to stimulate the development of labor saving and time saving ideas that the Better Shop Methods Department was founded and its aim is to pass along these ideas for the benefit of the other fellow.

BETTER SHOP METHODS

Dual Toolposts Will Speed Up Production of Bushings

TO INCREASE production in bushing work or in turning parts of the general shape of a bushing, the lathe tool mounting illustrated is an expedient of value. The work is accomplished with a single tool set-up and only the stock and steady rest are moved to repeat the operation after one bushing is finished. In application this



With this double tool set-up the bushings are turned and bored at the same time

method resulted in cutting the time of production to one fifth the usual time and effected a corresponding saving in labor expended on the job.

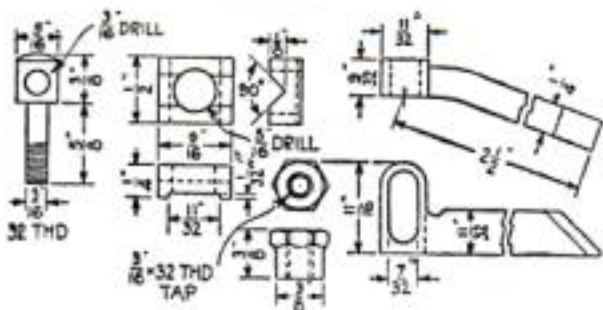
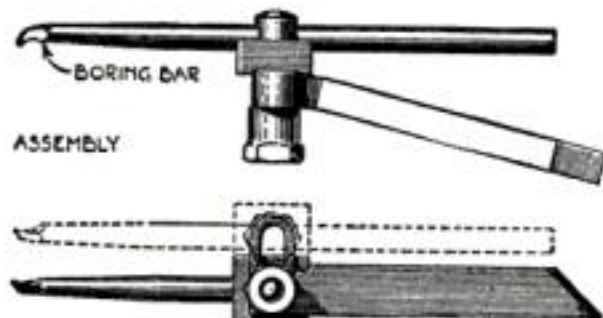
Two toolposts are mounted in the toolpost slot. One tool turns and the other bores the stock after a twist drill in the tailstock roughs out the center of the bushing.

The cross feed screw is then operated so that the outside turning tool cuts off the completed bushing.

A steady rest prevents the stock from springing.—G. A. LUERS.

Holder Raises and Lowers Bench Lathe Boring Tool

THE feature of this bench lathe boring-tool holder lies in the ease with which the tool may be raised or lowered to the center of the work. The parts of the holder



A useful tool for fine work on a bench lathe

and the method of assembling them are made clear in the illustration.

The tool is quickly made up and will repay the labor required many times over for any machinist who does fine work on a bench lathe.—S. L. ROBERTS.

"Drilling days are never over"



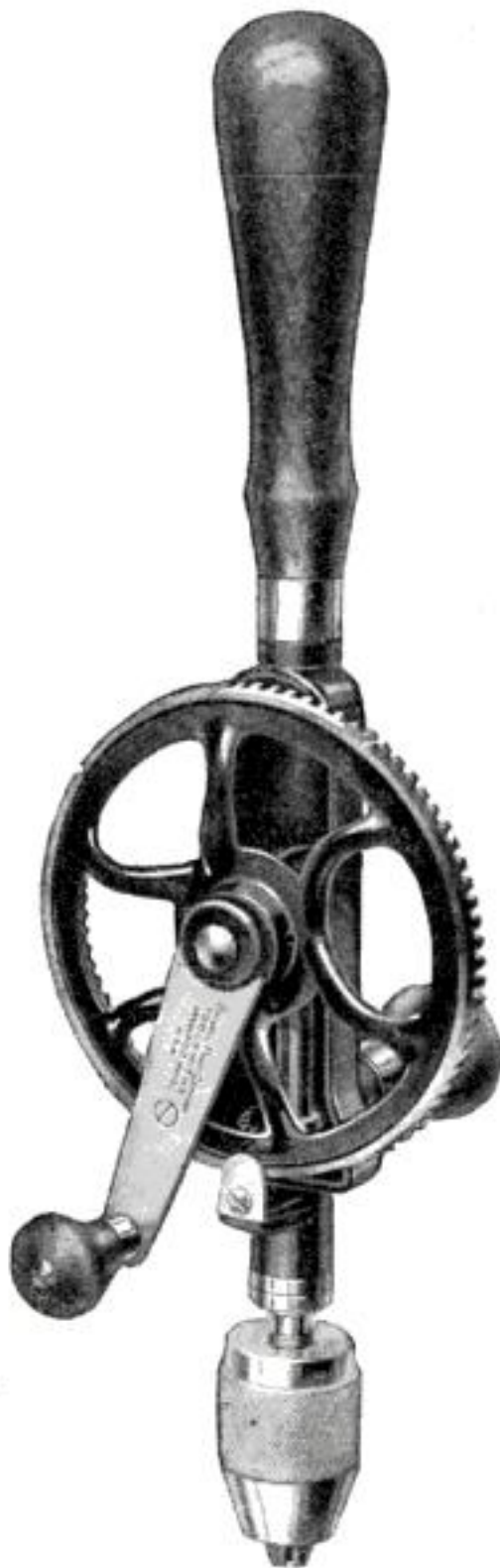
"Soldiers have a lot of drilling to do," observed Mr. Punch, "but so have carpenters and mechanics and any man who uses tools. For them every day is Drilling Day."

"I've found, however, that drilling a lot of holes has no terrors for the man who uses this Goodell-Pratt Hand Drill. It does its job so thoroughly that you'll consider it one of the best tool investments you ever made."

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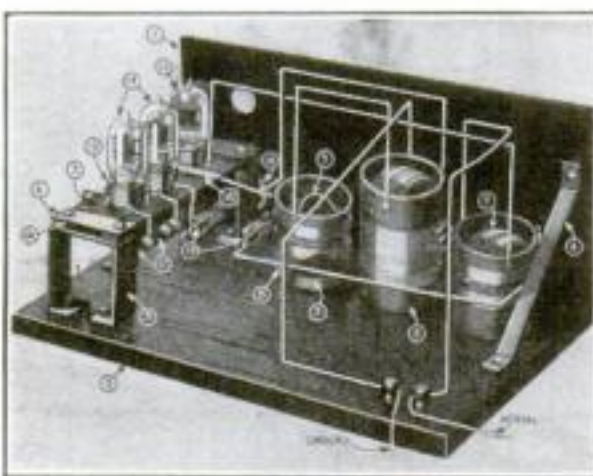
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P. S. Feb. '22



The vacuum tube set with two stages of amplification, from rear of panel

and bill of materials of a two-stage regenerative receiving set that a professional would be proud to own. It comprises a variocoupler and an Armstrong two-variometer-regenerative tuning circuit coupled, if desired, with two stages of audio frequency amplification.

The tuning coils have been selected because of the ease with which they may be constructed at home.

In this set has been incorporated the best features of several types of outfits. It will tune from 180 meters to about 600 meters with remarkable sharpness and selectivity.

BETTER SHOP METHODS

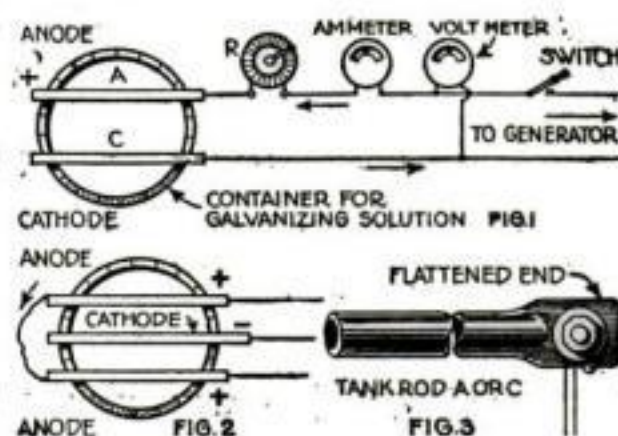
An Electrogalvanizing Process for the Small Shop

By K. M. Coggeshall

GALVANIZING is a process by which zinc is deposited upon another metal, usually iron. Because zinc furnishes an almost perfect protection from rust, it is widely used as a coating for iron and steel hardware, wire products, screws, nuts, bolts, and similar articles.

Until recently, practically all galvanizing was done by immersing the pieces in molten zinc. This hot galvanizing process calls for special equipment, skill, and presents a fire hazard. The more simple cold galvanizing or electrogalvanizing described here requires inexpensive equipment yet gives a smooth deposit of zinc of any desired thickness upon the treated work.

The equipment consists of a solution tank, a small electric generator, and sever-



Wiring diagram and detail of end of cathode and anode rods

al measuring instruments. While a manufactured wood or steel tank is much to be preferred, quite satisfactory results may be obtained with a half section of an old vinegar barrel. The inside surface of this container should be well covered with asphaltum paint to insure against acid leakage. Several such half barrels may be connected electrically in parallel, if necessary, to obtain the required capacity.

The Electrical Circuit

The source of electric-current supply may be either a battery or a generator. The former can be used only where the articles to be plated are small in size and quantity. Moreover, a battery has many limitations and requires much attention. A generator should therefore be secured having a current pressure of from 3 to 6 volts, but with a comparatively large current capacity. A current of approximately 2 amperes a square foot of plated surface is necessary. The generator may be driven by either a small gas engine or an electric motor, but its speed of rotation must equal that designated upon the name plate if the highest efficiency is expected.

The electrical connections should be made as noted in Fig. 1. Two brass or copper tubes, A and C, serve as the anode and cathode supports. If possible, two anode supports, as shown in Fig. 2, should be furnished, since such an arrangement of anodes allows a uniform deposit upon both sides of the plated work. One end of each tube should be flattened and drilled, as in Fig. 3, so a bolted connection may be easily made.

A rheostat is connected in the circuit to
(Continued on page 89)

BETTER SHOP METHODS

An Electrogalvanizing Process

(Continued from page 88)

regulate the plating current upon which the rate of deposit depends. If possible, an ammeter and a voltmeter should be used to indicate the working conditions.

Care must be exercised to see that the current flow is in the direction noted—toward the anode and from the cathode.

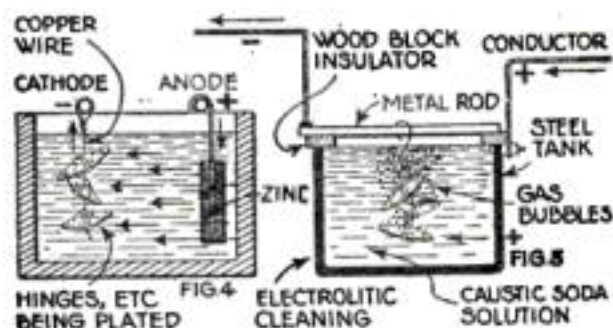
The anodes must necessarily be of zinc, commercially pure. While sheet zinc may be used, much better results are obtained if cast metal is employed. Commercial cast zinc anodes may be purchased in many forms—round or elliptical bars and flat or corrugated plates. It is usually best to provide an anode surface at least 35 per cent greater than the total area of the parts to be plated.

There are two general types of galvanizing solutions, acid and alkaline. The former is "fast," but unless care is taken, it tends to show a granular deposit. The latter forms the coating somewhat slowly, but usually produces a finer finish.

A simple formula for an acid solution is:

Water.....1 gal.
Zinc sulphate.....2 lbs.
Aluminum sulphate....4 oz.
Ammonium chlorid....2 oz.

Dissolve the zinc sulphate and the ammonium chlorid in a little water. The alu-



Diagrams showing method of the galvanizing process and electrolytic cleaning

minum sulphate is then dissolved in another portion of water and added to the first solution. Strange as it may seem, the addition of 1 oz. of grape sugar or glucose will improve the smoothness of the deposit.

Bath Must Have Acid Reaction

Precautions must be taken to make sure the bath is not neutral; it should have a slight acid reaction. Blue litmus paper, if dipped in the electrolyte, will turn red immediately if the solution is acid. Should this test show the bath to be neutral, add a very small quantity of sulphuric acid until the litmus paper no longer remains blue. A spongy, rough deposit is a good indication that the bath is in a neutral condition.

A much-used cyanide galvanizing solution, which should be heated when used, is:

Water.....1 gal.
Zinc cyanide.....4 oz.
Sodium cyanide.....4 oz.
Aluminum sulphate.... $\frac{1}{2}$ oz.
Caustic soda.....4 oz.

The zinc cyanide and sodium cyanide are dissolved in one portion of water, the caustic soda in another, and the aluminum sulphate in another. The three solutions are then mixed together.

The pieces to be plated must be chemically cleaned. The slightest trace of grease or oil, or even a finger mark, will cause the deposit to be defective. The pieces should be strung on short lengths of wire, or if this is not possible, placed in a wire basket. If

(Continued on page 90)



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BETTER SHOP METHODS

An Electrogalvanizing Process

(Continued from page 89)

the articles are quite rusty or covered with scale, it may be necessary to suspend them in a pickle bath for a short time. The pickle is usually composed of a solution of several diluted acids. Iron articles may be best treated in a bath of 20 parts water to one of sulphuric acid. If it is convenient to heat this pickle, the process will be shortened. Rinse well in cold, and in hot water after removal from the pickle.

Other Cleansing Precautions

One of the quickest and easiest methods of cleaning metal articles, however, is by an electrolytic process. A small steel or iron tank is used, the positive side of the generator being connected with it. The negative terminal is connected with the piece to be cleaned, which is suspended in a caustic soda solution contained in the iron tank. This solution should be maintained at a temperature near the boiling-point by some heating unit—steam coils, for example. The foreign substances on the treated articles are quickly thrown off by the action of the hydrogen gas formed on the surface. Note Fig. 5.

If these treatments fail to remove all stains, it may be necessary to polish the pieces, using a wheel set up with fine emery.

The foregoing cleaning processes may be omitted should the parts to be plated appear reasonably free from foreign matter. However, they must be immersed for approximately twenty minutes in a hot lye solution composed of from 30 to 40 parts of water to 1 part of lye, by weight. Rinse the pieces in cold water immediately after they are taken from the solution.

Scouring with fine pumice-stone is sometimes done where the surface still appears to require treatment beyond that of the lye dip.

Just before hanging the pieces in the tank, they are quickly dipped in an undiluted solution of muriatic acid to remove any existing oxid, and finally rinsed in clean, cold water.

The Plating Process

The pieces, still strung on the copper wire, are then suspended in the electrolytic bath, the free end of the wire being connected with the cathode support, C, thus completing the electric circuit. Note Fig. 4.

The plating current is carefully regulated by means of a rheostat, to obtain the desired fineness of deposit. Too heavy a current will "burn" or blacken the coating.

After removal from the bath, the piece should be rinsed thoroughly in hot water, then dried in warm sawdust.

A protective coating thus obtained will wear almost indefinitely.

Milling Thin Work

WHEN milling thin work, a coarse feed will distort the work less than a fine feed. Slight irregularities in the cutter cause some teeth to cut more heavily than the others, and as a high tooth comes in contact with the work, it strikes a blow that produces a slight peening action. With a fine feed, this peening action takes place a greater number of times in the length of the work and consequently causes greater distortion.—R. H. K.

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COUNTER

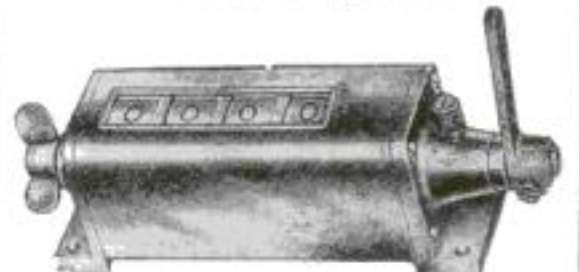
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BETTER SHOP METHODS

Tricks in Testing Bench Lathes

FOR some years I have been interested in small bench lathes. Until recently the method of testing was as follows: The test bar was inserted in the bearings and locked by screws in the bearing caps and a block with a V edge to correspond to the shears of the bed (front side) was used with a dial indicating gage. Measurements were made from the lathe bed to the test bar at the headstock close to the bearing, and again at the end of the test bar, 28 in. from the bearing. I had allowed an error of .002 in. in 24 in., the test bar projecting from the front bearing by about 28 in.

A question was raised as to the amount of deflection of the test bar, and I ventured

Testing alignment of headstock bearings



the opinion offhand that it would not amount to more than .0015 in. on the 28 in. length; but on referring to a textbook and using the given formula, the deflection proved to be .008. This upset all our calculating. When the bar showed zero at the headstock end and .002 in. high on top at the tailstock end at 28 in. overhang of the bar, it really was .010 in. high at the end instead of being only .002 in. as shown at the indicator, the deflection accounting for the .008 in.

Next, by taking a test at 12 in. overhang, the deflection was less than .001 in. Now to prove if the deflection was actually .008 in., the test bar was again inserted at 28 in. overhang and the bearings tightened up so that the bar was rigid. The gage showed at zero at the extreme end of the bar on the side test, with the lathe in its ordinary position. The lathe was then turned on its side 90 degrees and the gage again tried up against the bar, when it showed that the deflection was slightly more than .008 in. It actually registered .0105 in., showing that another factor had to be taken into account, and that was the pressure of the spring in the dial gage. A test was made on this and it showed that the pressure of the spring registered a deflection of .0025 in. on the test bar at 28 in. overhang. The diameter of the bar was $1\frac{1}{4}$ in. and it was made from ordinary good mild steel approximately 35 to 40 tons tensile.

We had the records filed away for future reference and decided that in future all our tests would be made on a bar projecting 12 in. from the headstock, as the deflection on this length was under .001 in. All this goes to show how easily one can be led astray until actual experiments are carried out and very carefully checked.—F. H. SWEET.



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Edited by J. Arthur Thomson

Professor in the University of Aberdeen, Scotland

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The Home Workshop

(Continued from page 78)

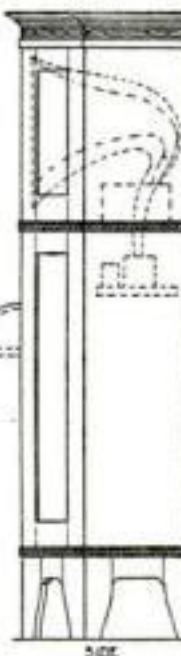
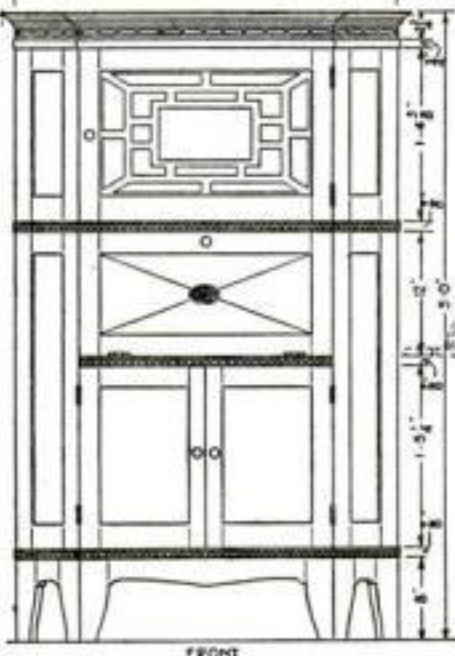
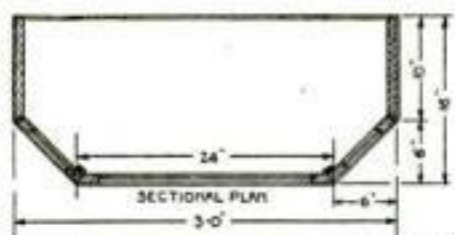
Building Your Own Radio Cabinet

AFTER mastering his home-made receiving set, the radio fan invariably wishes for a suitable cabinet. He wants something that will be as permanent and beautiful a piece of furniture as a cabinet phonograph.

There are many styles of cabinets that can be built at home, ranging from the simple



A walnut radio cabinet with inlays. Additional working details and a complete bill of materials are contained in Home Workshop Blueprint No. 16



in the middle compartment. The upper compartment with a fretwork door is for the loudspeaker, and if the horn is a very large one, the base of it is let down into the center compartment, as shown by the dotted lines. The lower compartment is for the A and B batteries, tools, and spare parts.

By taking care every step of the way, the builder can make, at relatively small cost, a cabinet that will not only be unique and different from anything that can be bought at furniture shops, but that will have a value as a handmade piece far in excess of what the average radio fan could afford to pay for a manufactured cabinet, as a glance at price lists would show him.

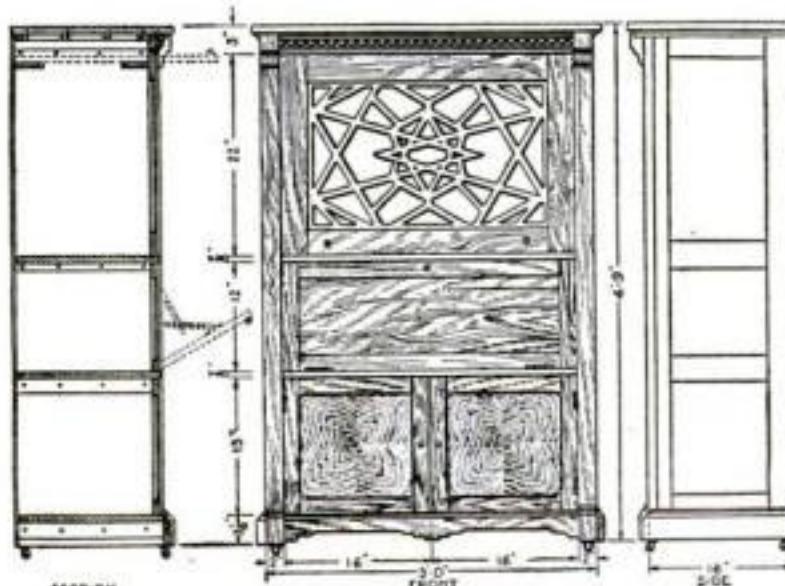
The frame is walnut and the panels are 5-ply burl walnut veneer. If burl panels cannot be obtained readily, try to pick out good stump veneer or fiddleback figures. It is not difficult to get veneers that are exceedingly beautiful in grain, that will stand out in contrast to the plain walnut of the frame. For cheaper construction use red gum for the frame either with walnut or red gum veneered panels. The top or cornice section, which has a stock molding,

and the base section and legs are made separately from the cabinet proper and are fastened to it with dowels.

The inlays, which add so largely to the attractiveness of the cabinet, are not particularly difficult to handle, since they are purchased ready made. A gage with the spur sharpened to a knife point, a

boxlike case described in the Home Workshop last May, to the elaborate inlaid cabinet that is illustrated above. For a crystal set a box serves very well; for a vacuum tube set it is better to make provision for the storage battery, unless it can be kept conveniently in the cellar and wires run from it up to the set. The cabinet also should provide a place for the loudspeaker, which invariably is added sooner or later to every set that has the necessary stages of amplification.

The cabinet shown above can be built by any home worker who has taken high school manual training or who has built pieces of furniture such as the home workshop kitchen cabinet, hundreds of blueprints of which have been used. The instrument panel and set itself are placed



Another simply made radio cabinet with compartments for the receiving set, loudspeaker, battery, and tools

THE HOME WORKSHOP

knife, chisels, and, if available, a scratch stock, are used for cutting the necessary recesses. These should be not quite as deep as the inlays are thick, so that, after the glue is dry, the inlays can be dressed flush.

The panel of the top door is fretsawed and backed with brown silk. If the modern craft finish is desired, stain the wood, brush it with one part shellac and one part denatured alcohol, paint it with thin silver gray flat oil paint, wipe the wet paint off across the grain and

(Continued on page 94)

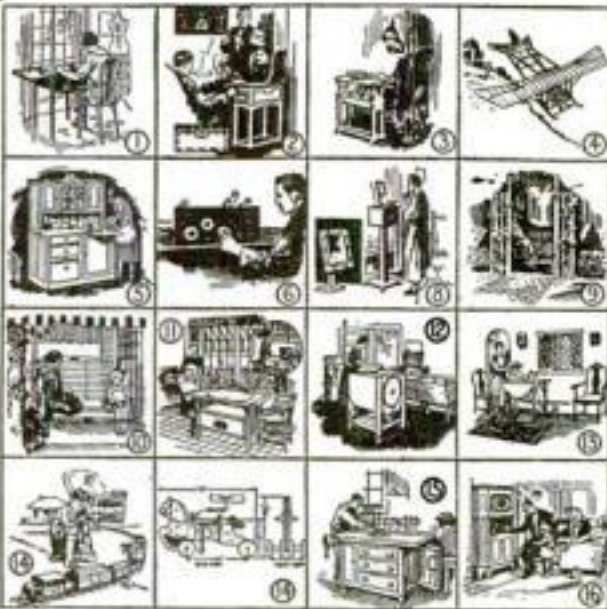


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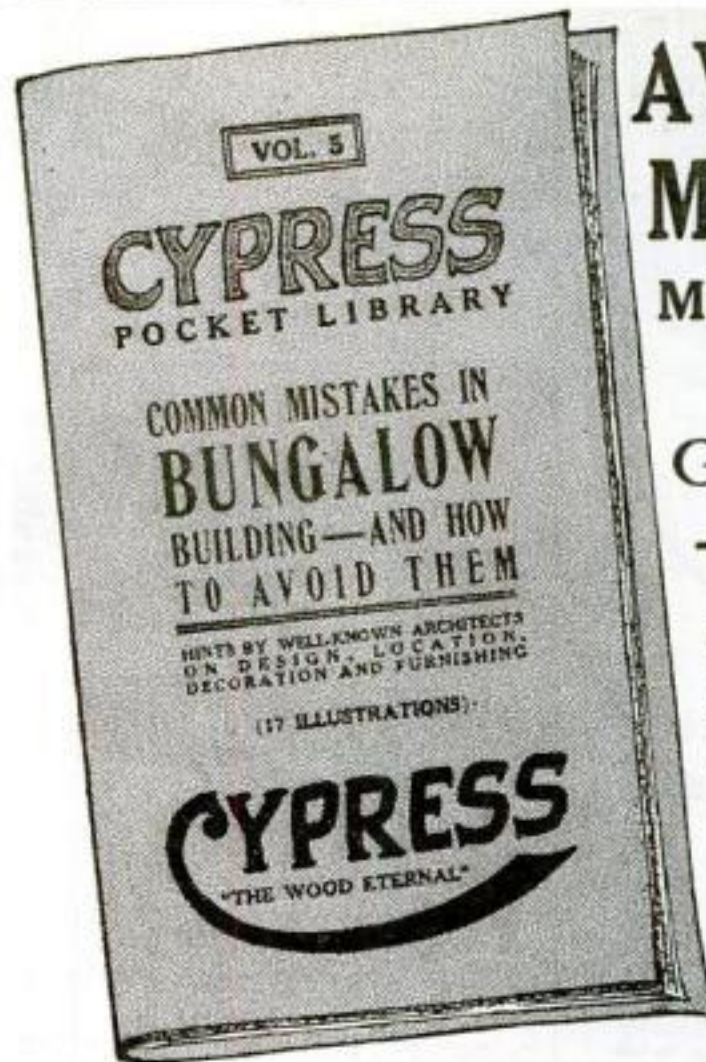
Above are illustrated the blueprints issued to date by the Home Workshop

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THE HOME WORKSHOP

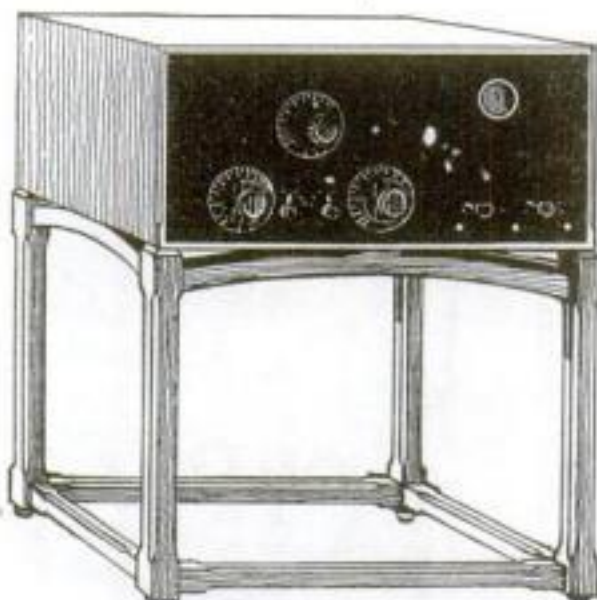
Building a Radio Cabinet

(Continued from page 93)

finish with several coats of good varnish.

If a loop aerial is used with this cabinet, it should have folding feet so that it can be slipped behind the cabinet.

The lower design on page 92 is a cabinet somewhat similar but without the cutoff



Boxlike cabinet supported by a simple stand

corners and the inlays; it is therefore easier to build and has an even larger capacity.

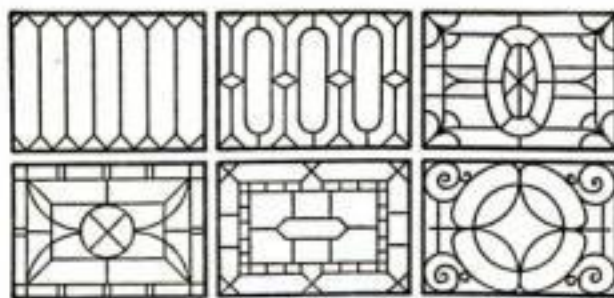
The cabinet on page 93 makes no attempt to conceal the loudspeaker, but the battery is hidden by a wooden cover, decorated with stenciling or inlays. Battery and cover slide out as a unit until the cover can be lifted off.

For the Dry Battery Set

A still simpler stand is illustrated at the top of this page; it is merely a support for a rectangular radio case. For a "peanut" tube set, with only dry batteries, shown at left, or a crystal set, it is as compact and neat a stand as can be desired. The cabinet has two small bookcases at each side of the compartment for the loudspeaker.



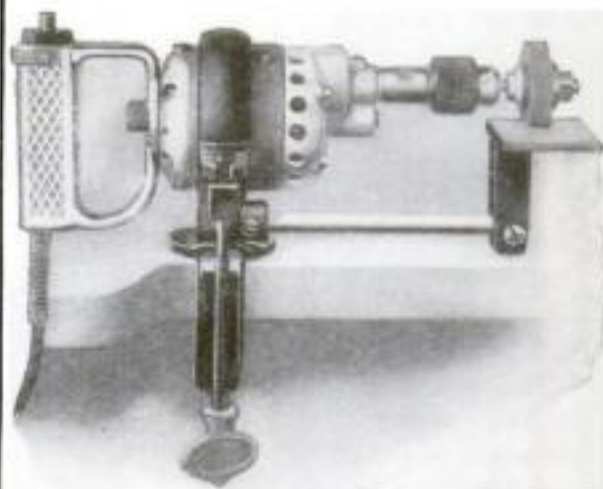
When time is limited, a good way of getting a cabinet is to buy a music or music roll cabinet or a phonograph record cabinet and adapt it for holding



A large cabinet with bookcases on each side of the horn chamber, and suggestions for fretwork doors

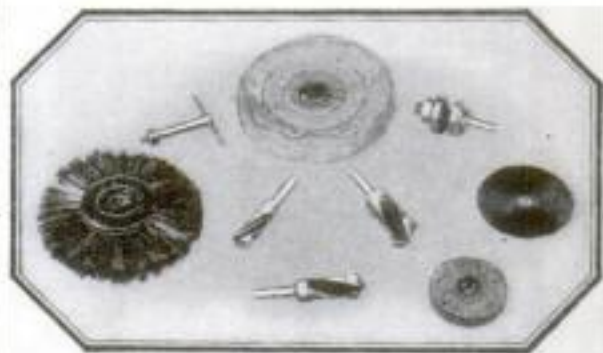
the set. It can then be improved at leisure, if desired, with either carving or inlays.

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THE HOME WORKSHOP

Prizes of \$15 and \$10 Offered for "Best Ideas"

TO ENCOURAGE readers of the Home Workshop to send in the good ideas they come across in their work with tools, two prizes of \$15 and \$10 are offered every month. These are awarded for the "Best Ideas" published for the month in the Home Workshop Department, and are a bonus given in addition to the regular rates of payment.

Any article suitable for this department is considered eligible for a prize, provided it is submitted by a reader or contributor not connected with the magazine staff. Each idea should be illustrated with a photograph, sketches, or both.

The February prizes are awarded as follows:

FIRST PRIZE, \$15: Howard Greene, New York, "Motor Drive for Bench Lathe Takes Up Little Room" (see page 118).

SECOND PRIZE, \$10: Ernest Bade, Glen Head, N. Y., "Taking Microphotographs without a Microscope" (see page 104).

Flying over the Ice Is Novel Sport for Skaters

By Dale R. Van Horn

WHEN the natural setting permits, skating parties can be enlivened by arranging an overhead trolley for what might be called ice flying. One skater at a time skates rapidly toward the pulley bar, as illustrated, grasps the handle and coasts as far up the wire as possible, and then turns in midair, so that as he travels back to the starting point, he will be ready to release the bar and resume skating.

To set up the cable it is necessary to find two tree branches that overhang the ice, about 75 yards apart. One branch should



An aerial trip requiring nerve and skill

be within 8 or 9 feet of the ground, the other 25 or 30 feet. To them fasten securely the ends of a very heavy wire or light steel cable.

The car is a light wooden or steel grooved pulley wheel 5 or 6 in. in diameter, a 20-in. length of 1-in. gaspipe, a tee coupling, and two 4-in. lengths of 1-in. pipe. One end of the long pipe is split for 4 in., the halves are flattened and spread to form a bearing for the pulley spindle, which is a $\frac{3}{8}$ -in. bolt. The lower end of this pipe is threaded for the tee coupling, into which the handle pieces are screwed.



Whatever else may fail

Linking city, village and farm, crossing mountain and wilderness, the telephone system challenges Nature in her strongholds and battles her fiercest moods.

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North, south, east, west—in winter and summer, in forest and desert—the telephone workers guard the highways of communication. Traveling afoot where there are no roads, crawling sometimes on hands and knees, riding on burros, or motor-

cycles, or trucks, they "get there" as they can.

When Nature rages to that point where few things can stand against her, when property is destroyed and towns cut off, the telephone is needed more than ever. No cost is too much, no sacrifice too great, to keep the wires open. If telephone poles come down with the storm, no matter how distant they may be, no matter how difficult to reach, somehow a way is found, somehow—in blizzard, hurricane, or flood—the service is restored.

Whatever else may fail, the telephone service must not fail, if human effort can prevent it. This is the spirit of the Bell System.



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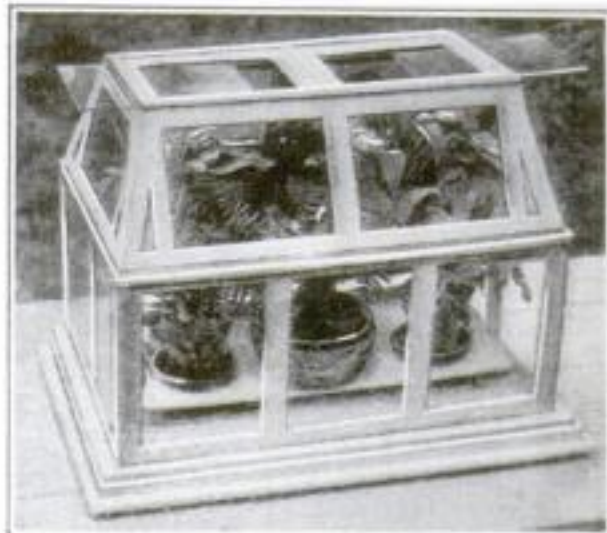
New York

THE HOME WORKSHOP

Miniature Greenhouse Made of Wallboard and Glass

TO THE lover of flowers this miniature greenhouse will make instant appeal. It is not only easy to make and attractive in appearance, but also, with its aid, the most delicate plants can be kept in the window garden successfully. Even orchids, those fairylike flowers, do well in this greenhouse, and other plants, like ferns and palms, develop prolifically.

The material necessary for constructing this ornamental glass house are two or



The finished greenhouse with two upper plates partly pulled out to air the plants

three sheets of wallboard or thick cardboard known as binding board, glue, tape, old photographic glass plates, a piece of galvanized screen, and wood from a box or two. The tools required are a chisel, hammer, knife, and metal shears. In addition to this, linseed oil and white lead or any other oil paint are needed.

The first consideration is the size of the old photographic glass plates that are available. The size used was 6 1/4 by 8 1/2 in., although smaller or larger plates can be used. For this size, three layouts were required, two for the sides, and one for the top. The thick binding board was used for this purpose.

The shape of the finished house is drawn upon the cardboard as shown in the photograph. The large



How the frames are laid out on wallboard or binders board. All the sharp corners are cut with a chisel

er rectangular pieces of cardboard, which are about 1/4 in. smaller than the glass plates, are carefully removed from the sheet, the corners being chiseled so as to get clean, sharp edges. Then, with a sharp knife and a ruler, these pieces are cut away.

When this has been accomplished, the three pieces are assembled and the edges

(Continued on page 97)



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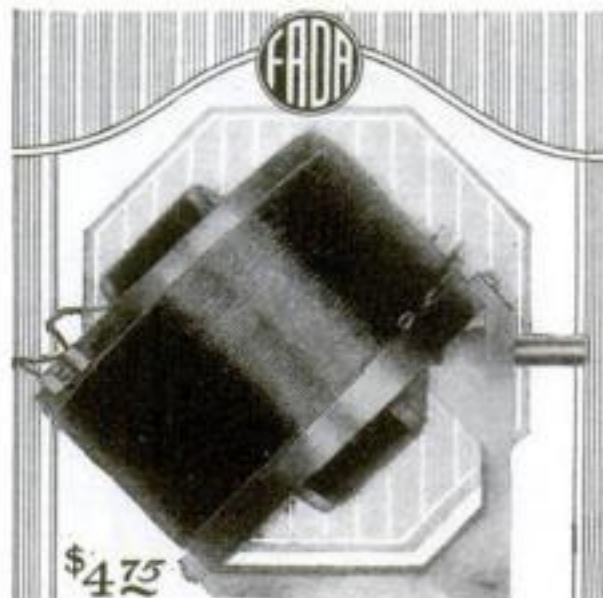
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THE HOME WORKSHOP

A Miniature Greenhouse

(Continued from page 96)

glued together with hot carpenter's glue and tape. It is advisable to glue all edges. Narrow strips of binding board are cut and glued vertically and horizontally on the bottom, in the center, and on the sides, to provide for the thickness of the groove that later will hold the glass in place. Over these strips another face, the exact size of the original frame, is glued. The narrow grooves thus provided allow the glass to



The framework sections are fastened together with carpenter's glue and tape

slide easily so that the panes can be cleaned or replaced when accidentally broken.

As soon as the glue is dry, the whole cardboard frame is loosely fastened to a board and thoroughly painted with linseed oil. This process must be repeated again and again until no more oil will be taken up by the binding board. Then the whole frame is given two coats of white lead.

In the meantime, two things are to be accomplished. One is to make a small bench fitting loosely under the greenhouse and containing two or more shelves, depending on the size of the flowerpots to be placed on it. The other is to prepare a strong, serviceable baseboard provided with a conventional molding. These parts should be painted or stained, as desired.

It is, of course, obvious that one or more of the glass plates can be removed and a

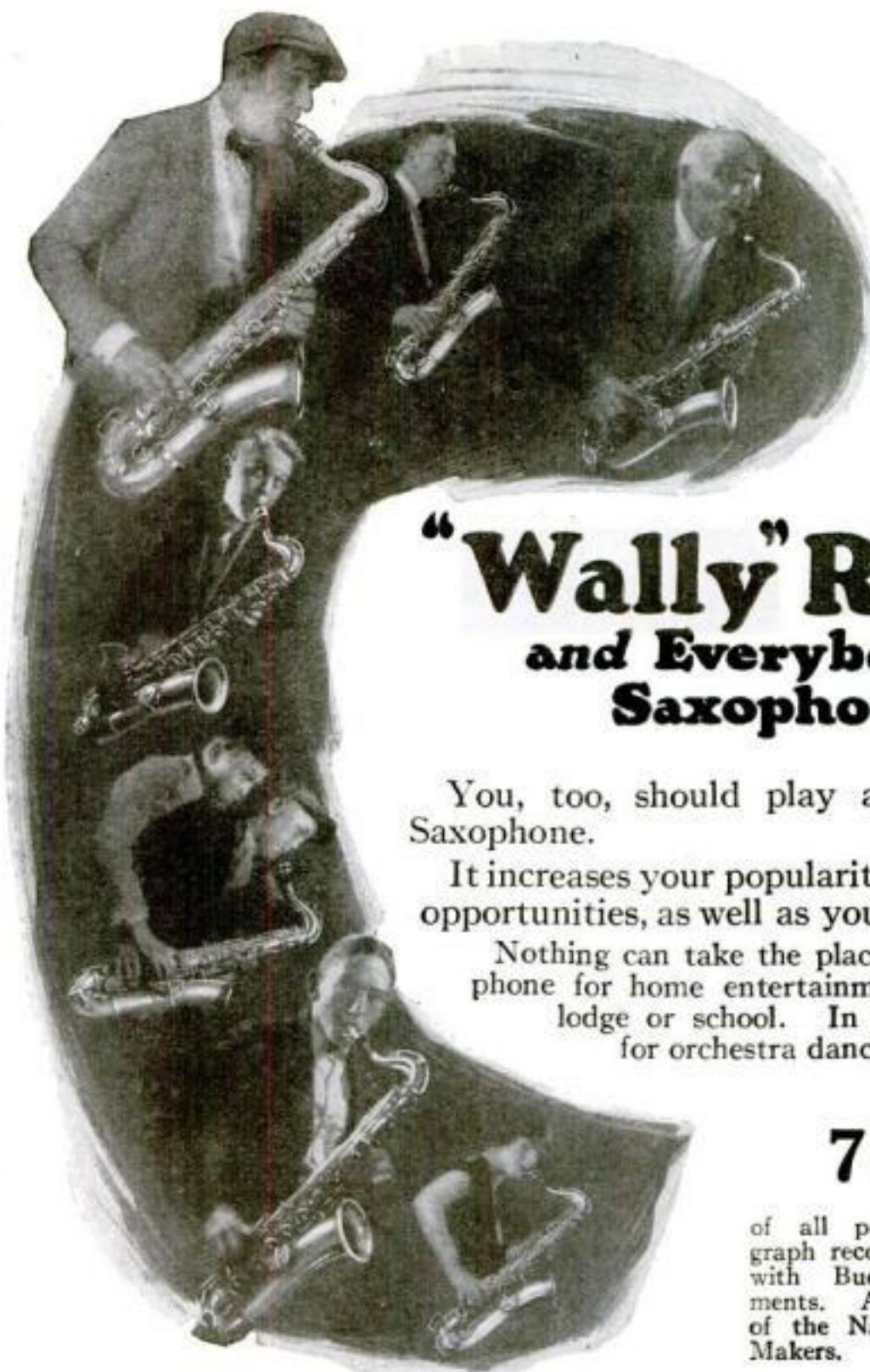


Face pieces similar to the main frames are glued on to complete the glass grooves

piece of screening, similar in size, substituted when weather conditions so require. Otherwise, one or two of the plates are partially pulled out to give the plants fresh air.

The advantages derived from this miniature greenhouse are many. Not only can seeds be sown under its cover, and ordinary house plants brought to flower, but also many beautiful but delicate plants can easily be cultivated.—E. B.

A CURTAIN spring makes a good emergency fan belt for an auto and I am always very careful to carry one in case a roadside repair is necessary.—C. J. WATTERS.



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THE HOME WORKSHOP

Bed Tent Brings Comfort to Outdoor Sleeping

[This bed tent was designed by a World War veteran who is a "T. B." patient and has been used by him for two years.—THE EDITOR.]

THOSE who like to sleep with the windows wide open or are forced to do so because of illness, find that many disadvantages are involved. Rooms get so cold that it is most uncomfortable to dress in the morning, hot water heating systems freeze, and there is a considerable waste of coal in heating up the room for daytime use. The bed tent illustrated does away with these discomforts. The construction



is such that the whole outfit can be taken down in a few minutes and stored away.

The tent is held to the window and window frame by awning buttons. The bottom edges are loaded with lead so that they will cling to the bed and prevent cold air getting into the room.

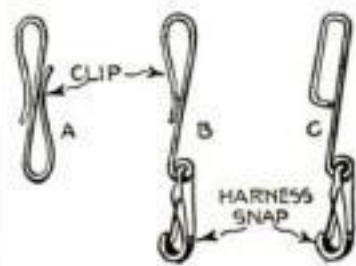
A distinct advantage lies in the celluloid window, because the occupant can see without having to lift the tent. The two upright supports are 1-in. angle irons clamped to the bed frame with wingnuts. Eyelets are provided at the inside upper corners of the tent and harness snaps are fastened to them. These snaps engage coil springs attached to the upper ends of the angle irons for the purpose of keeping the tent stretched and out of the sleeper's way.—GERMAIN CARON, Quebec, Can.

This Key-Clip Stays Put

HAVING lost two valuable bunches of keys by having the clip work off the belt, I set out to design a clip that would not come off and yet would be convenient to use. Finally I hit upon this clip.

I took an ordinary clip, A, cut off one end, and bent it around a small harness snap, B. Then I bent the other end to fit over the belt, as at C. The belt must be threaded in the slot.

On one occasion this arrangement withstood a strain that stretched a key ring into a straight wire. In making the clip, care should be taken to have the loop that fits over the belt and the snap on the same side. In this way the snap is easily reached. The clip part, when caught, pulls down the belt.—E. V. C.



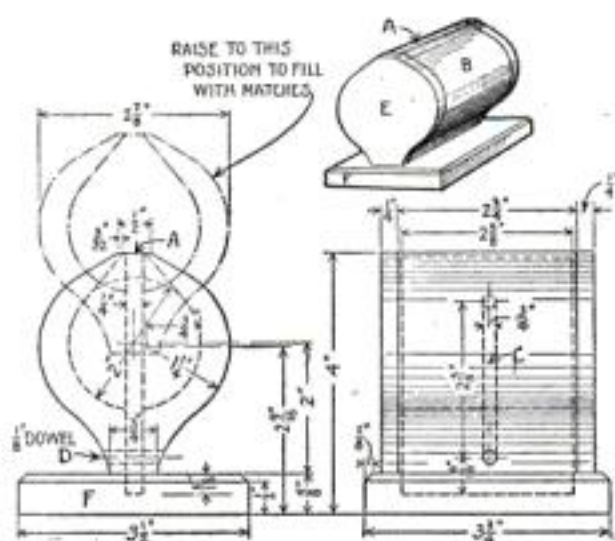
THE HOME WORKSHOP

Unique Match Safe Supplies
One Match at a Time

By Harry R. L. Chellman

A UNIQUE and useful automatic match safe may easily be made by following the details in the accompanying illustration.

Any kind of wood may be used, either hard wood, such as oak, maple, and birch; or soft wood, such as mahogany, poplar, and white pine. First, cut a block $2\frac{1}{8}$ in. wide, $3\frac{3}{8}$ in. thick, and $2\frac{1}{4}$ in. long for the body, B. Make the 2-in. hole indicated by the dotted circle in the end view with a 2-in. expansive bit, or use a smaller bit and gouge the hole to the size and shape indicated. Then cut the outside to the desired



Details of an automatic matchbox, which is made entirely of wood

shape and saw the piece in half. Plane the two sawed faces to dimensions.

Make the base F, the two ends E, and the center partition A according to the drawings. A groove is gouged in the top edge of the partition to retain one match, and a slot is cut as at C, to engage the dowel D. Sandpaper all parts.

In assembling, fasten the end pieces with brads, leaving just enough space between the two halves of the body for the partition A to slide freely, without too much play. Next, fasten the partition in the mortise in the base F with glue and brads. Put the parts together and insert the dowel through the slot S. Stain and polish as desired.

To fill the receptacle, raise the body B to position shown by the dot and dash line and drop the matches through the slot. To operate the match safe, simply raise body B and lower it again to original position. This deposits one match in the groove.

Gaging Internal Threads

THE home mechanic often is obliged to find the pitch of internal threads in small tubes, machine parts, and fixtures of one kind and another. The ordinary external thread gage of the leaf type is of no

assistance in cases when the leaf is too large to enter the threaded bore. Sometimes a male screw can be found that will fit and then its thread can be gaged, but if not, the difficulty may be overcome by whittling a piece of soft wood to a diameter small enough to allow it to be screwed into the tube. When it is unscrewed, an impression of the thread will be left upon it sufficiently clear to allow it to be gaged with the external thread gage.—C. M. WILCOX, Torrington, Conn.



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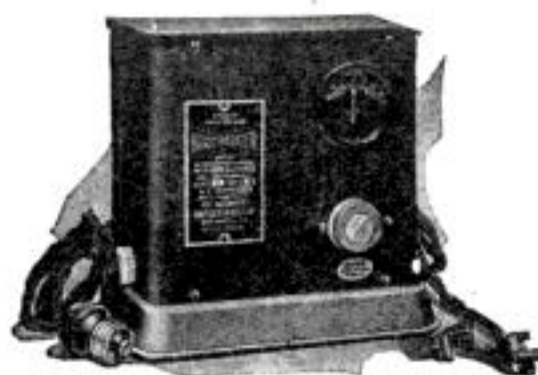
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THE HOME WORKSHOP

Billy and Fido Toy Illustrates a Mother Hubbard Tale

By Charles L. Miller

OLD Mother Hubbard, on one of her many returns to her cottage, found her dog riding the goat and this toy illustrates that tale. The general arrangement is shown in Fig. 1. As the car is drawn along, a cam causes the goat to buck up

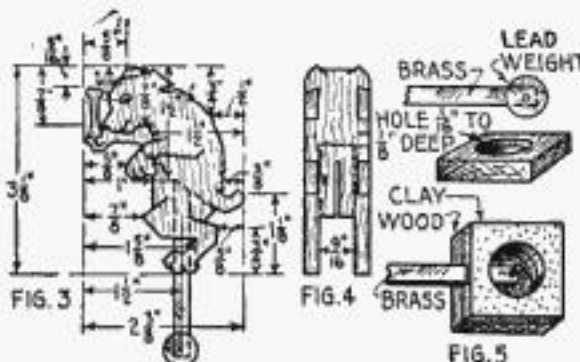
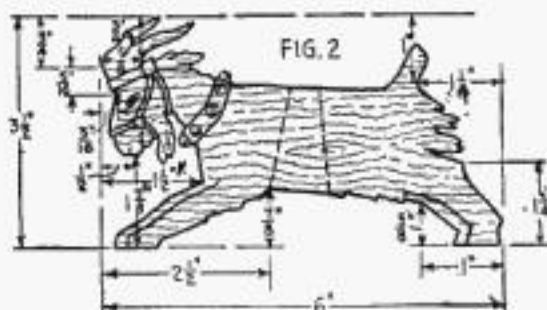
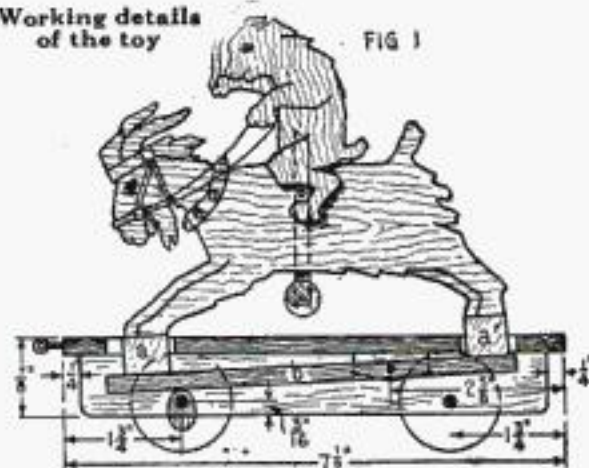


and down, but the dog always maintains his balance.

First, saw out the goat with a coping or jigsaw, from a piece of wood, $\frac{1}{2}$ by $3\frac{1}{2}$ by 6 in., Fig. 2. Then make a slot $\frac{1}{8}$ in. wide through the body of the goat, as indicated by the dotted lines in Fig. 2. This can easily be done if several $\frac{1}{8}$ -in. holes are first drilled through the piece.

The dog, Fig. 3, should then be cut from a piece of wood, 1 by $2\frac{3}{8}$ by $3\frac{1}{8}$ in. This is a thicker piece than the goat because the

Working details
of the toy



dog's legs straddle the goat's back. The dog can be carved out a little for the sake of realism, as indicated in the rear view, Fig. 4. A brass strip with a lead weight cast on the end, as shown in Fig. 5, is passed through the slot in the goat's body

(Continued on page 101)

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THE HOME WORKSHOP

Billy and Fido Toy

(Continued from page 100)

and is inserted in a slot in the dog's body, and fastened with two brads. Another brad through the goat's body and the brass strip, shown in Fig. 1, serves as a pivot, so that the dog's body will swing freely just over the goat.

The goat is fastened to 2 blocks (Fig. 1, a), $\frac{1}{2}$ by $\frac{1}{2}$ by $\frac{5}{8}$ in., that, in turn, are attached to a walking beam, b, $\frac{1}{4}$ by $1\frac{1}{2}$ by 6 in., under the floor of a simple flat car. The walking beam is pivoted between blocks $\frac{1}{4}$ by $\frac{1}{2}$ by $1\frac{1}{4}$ in. The platform is $\frac{1}{4}$ by $3\frac{1}{2}$ by $7\frac{1}{2}$ in., and the side pieces, $\frac{3}{8}$ by $\frac{5}{8}$ by 7 in. The wheels are wood button molds $1\frac{1}{2}$ in. in diameter, with axles made from $3/16$ -in. dowels. To the front axle is attached a cam block to raise and lower the walking beam.

Resistance Unit for Recharging Radio Storage Battery

By J. M. Rolston

A PORTABLE resistance unit, like the one illustrated, for charging radio storage batteries from any direct current lighting socket permits the owner to draw six amperes without using a cumbersome bank of lamps. The construction is exceedingly simple and inexpensive because standard parts are used.

I was led to develop this unit because of the impossibility of purchasing resistance wire in small quantities in the open market.



Finally I discovered that a heating element in long cartridge form was being sold for basin-shaped, reflector-type electric heaters. The wire is wound on a fireclay tube and has a screw base. I purchased one for \$1.25 and found by actual test that it passed

$6\frac{1}{2}$ amperes at 110 volts d.c.

To get rid of the heat as quickly and safely as possible, I screwed the cartridge into a porcelain extension socket with a side tap and surrounded it with a heavy glass cover from an engine sight feed oil cup. The glass was held by two fixture globe brackets, the one next to the socket being fastened in position by a brass collar just large enough to slip over the base of the resistance unit and held in place by three No. 10/32 setscrews.

The side tap extension receptacle is taken apart by loosening a screw in the base, and one of the side taps is separated from its connection with the main line, but left attached to the shell by a screw so that it will be in series instead of parallel with the main line. When a cord from the radio battery is plugged into the tap, the circuit is complete.

Only one precaution is necessary—to mark the side plug points so that the same blade will always be plugged into the same hole. Test the battery leads for polarity the first time the unit is used.

The oil cup glass costs 33 cents, two fixture holders, 5 cents each, and the porcelain extension 50 cents, making a total of \$2.18 with the resistance unit.



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THE HOME WORKSHOP

Radio Receiving Set Operates on 110-Volt Direct Current

By Arnold Holmes

TO THE majority of radio experimenters, audion receiving sets spell storage batteries, which are always expensive and must be charged frequently. The wireless fan who has spilled acid from his battery on a rug and has found it necessary to buy B batteries frequently, can avoid all his difficulties if he has access to 110-volt direct current mains, for he can build a receiver to operate entirely from them.

The story of the connections of this receiver is told by the circuit diagram, Fig. 1.

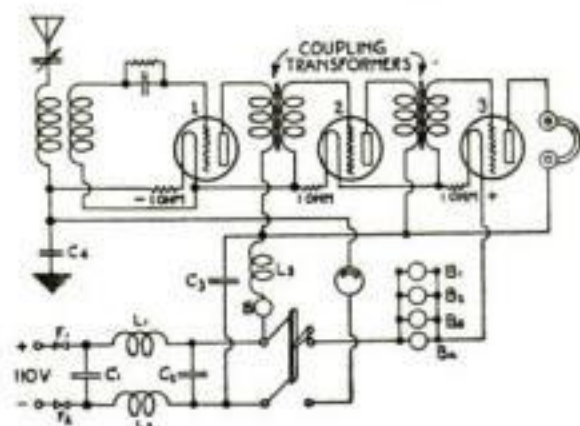


Fig. 1. Wiring diagram of set operated entirely with current from 110 d. c. mains

Any noise that is introduced in the filament circuit of the receiver by the power circuit can be eliminated successfully by the combination of coils and condensers L_1 , L_2 , and C_1 , C_2 . The condensers should each have a capacity of about 10 microfarads and can be made up of 2 microfarad telephone condenser units.

The easiest form of inductance for the experimenter to build is illustrated in Fig. 2. The core can be made up of transformer iron laminations or well annealed iron wire that has been given a covering of shellac. It is possible to obtain this wire cut to length and straightened from a steel wire company.

The fuses F_1 and F_2 should be installed for protection, and can be of 5 amperes capacity. This will protect the source of supply from accidental short circuit.

The current through the three receiving tubes, connected in series, can be adjusted

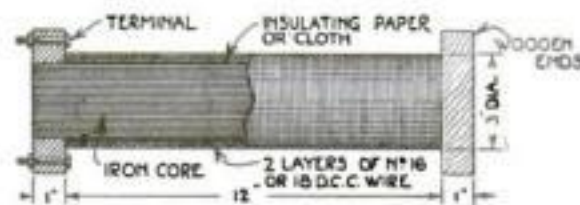


Fig. 2. The inductances used can easily be wound

to the right value by screwing in the proper number of 160-, 25-, 15-, or 10-watt tungsten or carbon filament lamps. The condenser C_4 connects the radio receiver with the ground and prevents a short circuit in case the power circuit is intentionally or accidentally grounded. The condenser should have a capacity of 2 microfarads and can be of the type used in telephone work. This condenser effectively prevents the passage of the direct current, but offers a very low impedance to currents of the frequency of the received signal.

It should be pointed out that the filaments are connected with the negative terminal of the power supply and that the

(Continued on page 103)



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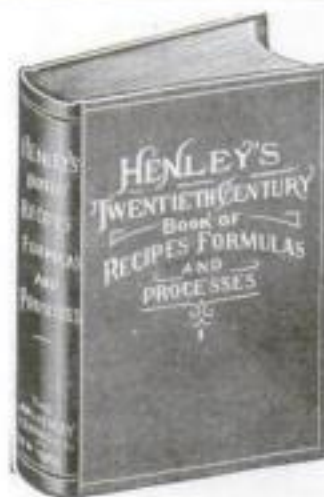
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THE HOME WORKSHOP

Radio Receiving Set

(Continued from page 102)

greater portion of the drop in potential necessarily occurs across the lamp bank.

The plate potential is obtained from the same source and in general should be made to pass through an additional coil and condenser to remove any noise still remaining. The condenser C_3 should have approximately 6 or 8 microfarads capacity and the inductance should be similar to that shown in Fig. 3. A 10-watt tungsten filament lamp is included in the plate circuit of the receiver for protection. If the plate lead is short-circuited at the receiver, the lamp lights up and the current is limited to 1/10 ampere. The lamp does not light up with a normal current taken by the receiver, and the lamp causes but a small drop in voltage across it.

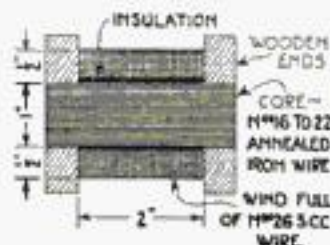


Fig. 3. Inductance for the plate circuit

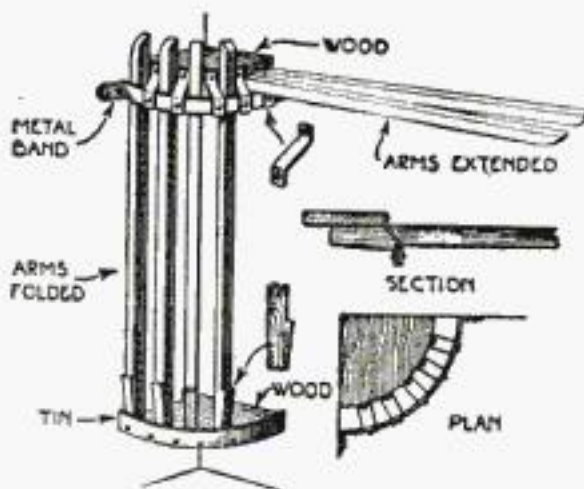
The plate potential applied to tube No. 1 is equal to the voltage of supply, say 100 volts, less the drop in voltage across L_1 , L_2 , L_3 . That across tube No. 2 will be less than that across tube No. 1 by the amount of the filament drop across tube No. 1.

With this receiver very satisfactory results have been obtained without the expense and care of storage batteries for the filaments or dry batteries for the plate.

Neat Display Rack for Store Has Collapsible Arms

THIS collapsible display rack, installed in a Washington, D. C., store, is of especial interest because of the manner in which the arms fold out of the way when not in use so that one or more may be used independently of the others. The construction is simple and inexpensive.

The arms are shaped as shown, and the base and upper bracket are quarter sec-



The arms raise up and swing out when needed; otherwise they take up little room in the corner

tors of a circle. These parts are all of wood. An iron band attached to the walls and the upper bracket is the support for the extended arms, which protrude in a fan shape when raised.

The rack is inconspicuous and does not take up any floor space in the store when folded. Draperies and clothes are displayed on it, but it would also be useful for hangings, wallpaper, and other materials.—G. L. K.



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for TWO HOURS WORK

In answer to a request from Chief of Police, Warren Biglow, the Finger-Print Expert arrived at the scene of the daring robbery of the O—Company offices. \$6500.00 in currency was gone. Not a single clue had been found.

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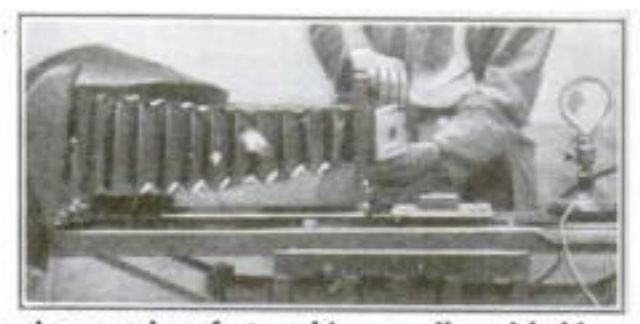
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THE HOME WORKSHOP

Taking Microphotographs without a Microscope

By Ernest Bade

THE past few decades have seen an amazing development in the manufacture of lenses suitable for the compound microscope. But since such an instrument is expensive and often is employed only in photographing objects too small to be seen readily with the eye, a different method, requiring only one well ground lens for both enlarging and photographing, will frequently serve satisfactorily. Such a



A convex lens fastened in a cardboard holder takes the place of the camera lens

method has its limitations, however, and, although tiny objects can be photographed, they can not be magnified indefinitely.

Sections through the stems of our common woods and shrubs, which give us an intimate glimpse into their structure and function, as well as many marvels of the animal world, can readily be photographed. Insects, such as dragonflies, bees, grasshoppers, and flies, can be taken so as to show that they have compound eyes made up of six sided elements, while crayfish, which belong to the same phylum, have com-



Mounting the treated object

compound eyes consisting of four sided elements. Then, too, the brightly colored butterfly wing defines itself into numerous overlapping scales, every one of them

most delicately fluted and ribbed.

These structures, as well as countless others, can be cut with a razor and examined by the method to be described, provided the object is placed successively in 30, 45, and 60 per cent alcohol, stained, if necessary, in eosine, carmine, or aniline; and, finally, treated in 95 per cent and absolute alcohol. The object must remain at least two hours in each solution and then be hardened in xylene for the same length of time.

The object is then ready to be mounted. It is placed on a glass slide, carefully covered with a drop of Canada balsam and a glass cover gently lowered upon it so that air is excluded. It is placed horizontally and slightly weighted until the balsam has quite hardened.



The finished slide

When the slide is finished, it is held upright by means of a wooden clip, the object being placed at such a height that it lies in the exact horizontal center with the lens. The character and type of lens used will, of course, influence not only the sharpness of

(Continued on page 105)



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THE HOME WORKSHOP

Taking Microphotographs

(Continued from page 104)

the image, but also the magnification. Satisfactory results are only possible with an accurately ground lens; cheap ones may be used for one or two magnifications, while the best grades are necessary for enlarging from 10 to 50 or more diameters.

A double bellows is convenient, since the longer the bellows, the greater the magnification. The addition of a 1 and a 2 ft. tubular section to lengthen the bellows, is desirable. But here it must be remembered that, while the object is enlarged, the finer details, although correspondingly increased in size, are not so distinctly enlarged with a long bellows as when a smaller lens of greater magnifying power is used with a bellow extension that is smaller.

Various types of lenses should be tried before pictures are taken with them. After removing the plate that holds the lens, or only the camera lens, as the case may be, make a cardboard plate that will snugly fit into the vacant place. Then, taking any plano-convex or double convex lens, cut a hole in the center of the cardboard and insert the lens. Bring the microscopic object glass near the lens and focus until a sharp, clear-cut image is thrown on the ground glass. If the image is at all foggy through interference colors, reject the lens and try another. This is of fundamental importance, for good photos, clear to their least detail, can be secured only when the lens throws a clear image upon the ground glass.



Part of peacock fly wing
15 mm. long

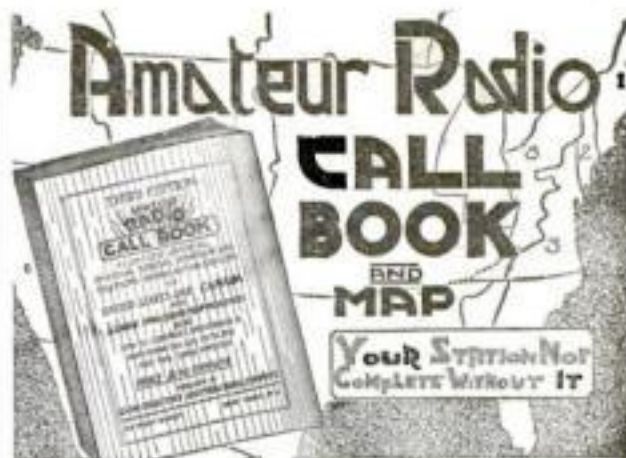
when the lens is smaller, only a fragment of the object can be taken.

It must not be forgotten that the camera lens is not used; a perfectly ground convex lens is all that is required. The light of a strong lamp is thrown from the back through the object, into the lens, to the ground glass. The exposure, which varies with the illumination, is a short one, a small piece of cardboard being held in front of the lens just before the picture is taken to cut off the light. The cardboard is removed to expose the plate and put back to cut off the light, the shutter then being replaced in the plate holder.

SLAG from blast furnaces is a cheap and useful aggregate for concrete. It should, however, be properly air-cooled and aged.



Microphotograph of
vinegar fly 3/20 in. long



The Book for Radio Fans

The New Edition of the **AMATEUR RADIO CALL BOOK** is the most complete directory of amateur stations published to date — listing Amateur, Special Amateur and Telephone Broadcasting Stations of the United States and Canada, also describes the Construction and Operation of a Honeycomb Coil Set, Detector and Two Stage Amplifier.

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of the United States and Canada, size 2 x 3 feet, supplies an indispensable requisite of every radio station. The nine radio districts, broadcasting stations, standard time areas, etc., etc., clearly indicated.

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Small Current— Big Job!

*Care in Selecting Your "B" Battery
Cures a Whole Flock of Static Troubles*

A lot of radio bugs are missing a good bet when they fail to give the proper attention to the "B" Battery that supplies current to the plate circuit of the vacuum tube. In a good many cases—and this applies to the seasoned enthusiast as well as the newest novice in the ranks—it is wrongly set down that since this current is so exceedingly small it cannot be very important.

Nothing could more completely misrepresent the facts. True enough, the current supplied by the "B" battery to the plate circuit is small—but it is precisely for that reason that even the slightest variations or disturbances are to be so carefully avoided.

In thinking of "B" batteries keep this in mind: The current from these batteries goes directly into the fine windings of the coils of your phones. Therefore even the slightest disturbance or unbalancing of the battery is translated directly into noise.

Obviously the reason for carefully soldered connections, loop aerials, short leads and the elimination of useless wires is to do away with noise just as far as possible. The same reason should dictate the careful selection of "B" batteries. It hardly pays to go to a great deal of trouble in taking the usual steps to eliminate static unless you also pick out a battery that is free from the hissing, sputtering and frying noises that are so often confused with static and that in common with static noises are multiplied six or seven times with each stage of amplification.

A "B" battery that is completely in accord with the efforts of manufacturers of sets to do away with static disturbances is known as the Willard "B" battery. This battery consists of a group of twelve glass-jar cells, assembled in oak cases and connected with heavy burned-on connectors. Due to the distance between jars electrical leakage from one jar to the next is practically impossible. As each of the cells has Willard Threaded Rubber Insulation between the plates there is no opportunity for leakage from plate to plate.

It is said by those who have carefully examined the construction of the Willard Radio "B" battery that, in addition to its ability to give results without distracting noises, it will last—if not a lifetime—at least such a long period that it will show a material money saving long before it begins to exhibit even the slightest sign of age.—(Advertisement.)

THE HOME WORKSHOP

How I Made Money with Odd Repair Jobs

I ALWAYS have had a shop in which to putter and tinker at making things, and when I needed money to build a wireless set, I turned to my tools to help me earn it. I found a demand for some one who would do little things that didn't require a carpenter—placing an extra bolt on a door, making a sidewalk, building and repairing fences, placing a board on a porch floor, and similar jobs. If any lad of high school age



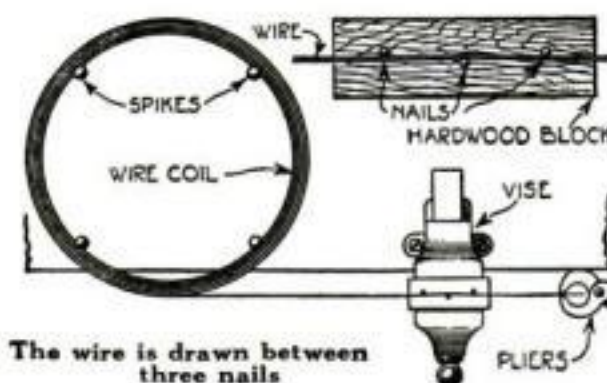
will look for this sort of work, he will find, as I did, that soon he will have more than he can handle.

Noticing that there was a demand for porch swings, I began to make them. I needed a quantity of thin oak paneling and in my frequent visits to a second hand store, I noticed one day a number of old wooden bedsteads. The proprietor said there was no sale for them, but that he had taken them in with the furniture from an entire house. Those beds looked like porch swings to me, and when I found out that he wanted only from 25 cents to \$1 each, I bought the lot. I got two swings, worth \$6 apiece, from each of the three frames, which also gave me paneling for chests, instrument boards, and other things of that kind.

The fact that I was able to earn money in this way kept me in high school and later allowed me to enter college, while the experience gained makes me practically independent of carpenters or repair men.—BENJAMIN B. DAWSON, Wichita, Kan.

Straightening Springy Wire

OFTEN wire, such as copper-plated spring wire and piano wire, which come from the factory in coils, must be straightened before it is used. A way to do this easily and quickly is by drawing



The wire is drawn between three nails

the wire off the coil through three nails driven in a block of hard wood.

The coil is placed over three or four spikes driven into the bench top, and the wooden block is held in the vise. The end of the wire is then threaded through the nails as shown. End-cutting pliers are used to draw the wire through.—M. F.

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THE HOME WORKSHOP

Test Lamp Prevents Burning Out Costly Vacuum Tubes

EVERY radio fan who experiments with new circuits can avoid the danger of burning out an expensive vacuum tube through short circuits if he will make it a practice to test the filament terminals of all sockets with an ordinary electric light bulb of the same voltage as the vacuum tube. Thus, when using a UV 200 tube, the test lamp is simply a 6-volt flashlight bulb.

If the wiring has become deranged or any mistake in the connections has been made,



Testing circuits with flashlight bulb

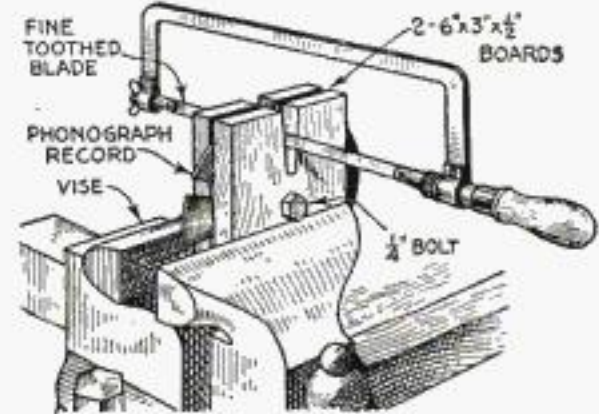
the test bulb, costing only a few cents, is burned out and not a vacuum tube. The rheostat should be tested at the same time, running the slider all the way around to see that there is nothing defective with it.

To mount the test bulb neatly, use an old vacuum tube base. Break the glass away and remove everything but the filament leads, which are then connected with the terminals of the small socket, as shown. The socket and base are molded into one unit with tar or other sealing compound.

—THOMAS E. MILLER, Nashville, Tenn.

Slotting Phonograph Records

ANY one who has tried to saw slots in a midget phonograph record or a piece of a large record in order to make spider web inductances for a radio set, knows that it is next to impossible to avoid breaking the brittle composition. The work can be



done easily, however, if two 1/2-in. boards, 3 by 6 in. are clamped together, a 1/4-in. hole drilled through their center and a notch sawn in them the exact shape and size of the notches that are to be cut in the record and located properly in relation to the hole.

The record is clamped between the pieces in a bench vise and a sharp fine-tooth hacksaw is used. The sawed edges should be slightly rounded with a file so that they will not cut the insulation on the wire.—EDWIN J. BACHMAN, Fullerton, Pa.

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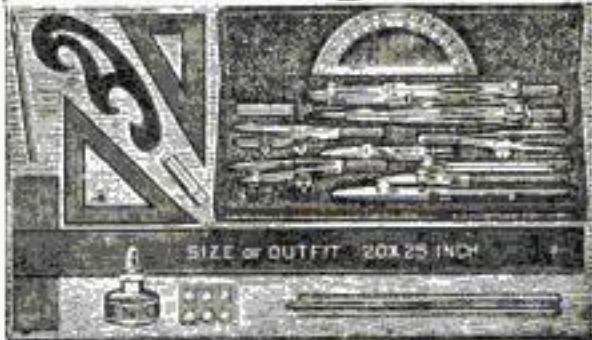
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THE HOME WORKSHOP

Postcard Projector Does Not Turn Views Backward

MANY postcard projectors show the pictures backward, with the printing reading from right to left, although some of the higher-priced machines use a prism and refracting lens to correct this fault. You may make a projector having this advantage, however, without using a prism and at very little expense.

Any reading glass will serve as a lens. Find its focal length by holding the lens between an electric light and a sheet of white cardboard, as in Fig. 1. Move it back and forth until the filament of the light is clearly defined on the cardboard, and then measure the distance between the lens and the cardboard; that will give you the actual focal length.

The box part is made of 1/8-in. wood, all the cracks being thoroughly puttied. A

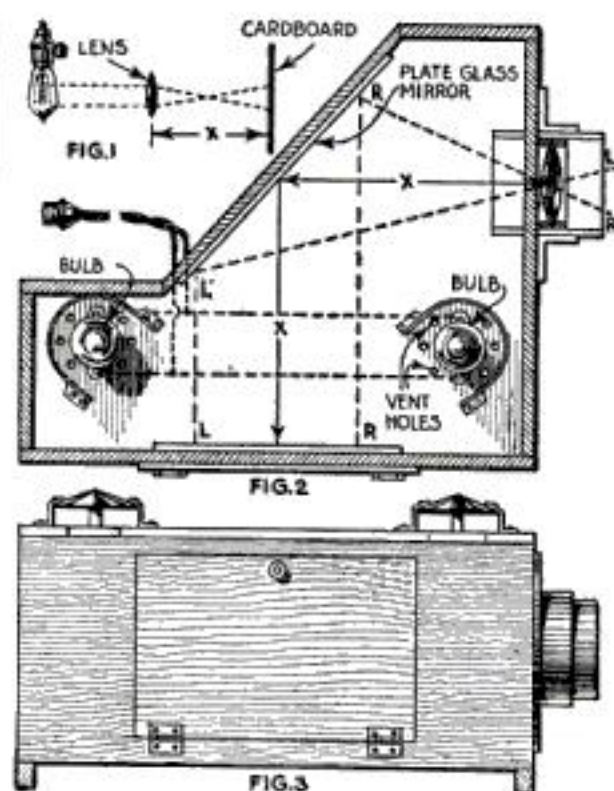


Fig. 1 shows method of testing focal length of lens; Fig. 2, the projector with top removed; Fig. 3, the side view

door on the back is hinged at the bottom. The construction should be such that there is a flange over the opening, so that no light will leak out when the door is closed. A metal clip is fastened to the inside of the door to hold the picture in position (Fig. 7). Two receptacles for 75-watt electric lights are placed so that with the aid of reflectors all the light is concentrated upon the door. The reflectors are cut from thin sheet aluminum or tin and bent as shown in Fig. 6.

Directly in front of the door is a plate glass mirror, set at a 45-degree angle (Fig. 2). The dimension X is the focal length of the lens. Opposite the glass on one side is the projecting sleeve, the outer part being fastened on the outside of the box by means of a square plate (Fig. 5). This sleeve can be made from an old tomato can. A tube containing the lens slides inside of this sleeve; another tin will serve for it. The lens is held in place by two rubber ring washers (Fig. 4).

Holes are cut into the top above the lights and over them are fixed small ventilator hoods (Fig. 3). They can be made from pieces of galvanized iron cut in the shape of 340-degree arcs and rolled into cones. Brackets for fastening the hoods to the box can be made from the same material and

(Continued on page 109)

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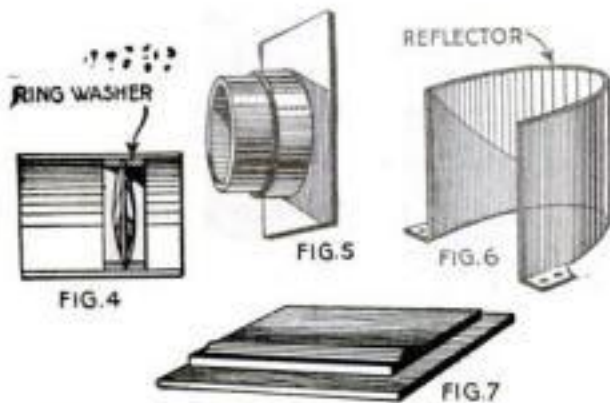
THE HOME WORKSHOP

Postcard Projector

(Continued from page 108)

riveted to them. In the bottom, around the lights, holes are cut to admit air, because when the lights are burning, they give off considerable heat and must be properly ventilated. Both lights are connected with one drop cord, as shown in Fig. 2, and the plug is screwed into an electric light socket.

A bed sheet may be hung on the wall to serve as a curtain. Place the projector on

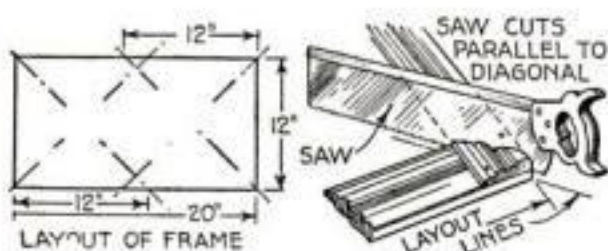


Details of lens mounting, reflectors, and picture holder on inside of door

a table or stand and move the tube that contains the lens in and out until the view of a card in the holder appears upon the screen bright and clear. The card should be placed in the projector upside down and the mirror then catches the view and reverses the left to the right, so that when the lens picks up the picture, it reverses it back to normal on the screen. In Fig. 2, page 108, L signifies left and R right. A projector of this type will work with photographs, pen and ink drawings, or any other printed matter.—EDWIN G. GETTINS.

Rough and Ready Method for Making Mitered Frames

OFTEN when the home mechanic wants to make a picture frame or other mitered frame, he has no miter box handy and doesn't wish to go to the trouble of making one. He can make perfect fitting corners, however, simply by laying out on the workbench or table the outline of the outside dimensions of the proposed frame, as shown. Measure along the two long sides a distance from the corners equal to



Lines laid out on bench take the place of miter box

one of the narrow sides. From these points draw diagonal lines through the corners of the rectangle to represent the lines of the miter.

One strip or piece of molding is placed on the table and another piece is laid on the top of it at right angles. Then both pieces are aligned on the layout and fastened together with small sprigs. By holding the saw parallel to the mitered line, a perfect cut may be made through both pieces. The process is repeated in each corner and no mistakes in size or squareness are likely to occur.—M. L. E.

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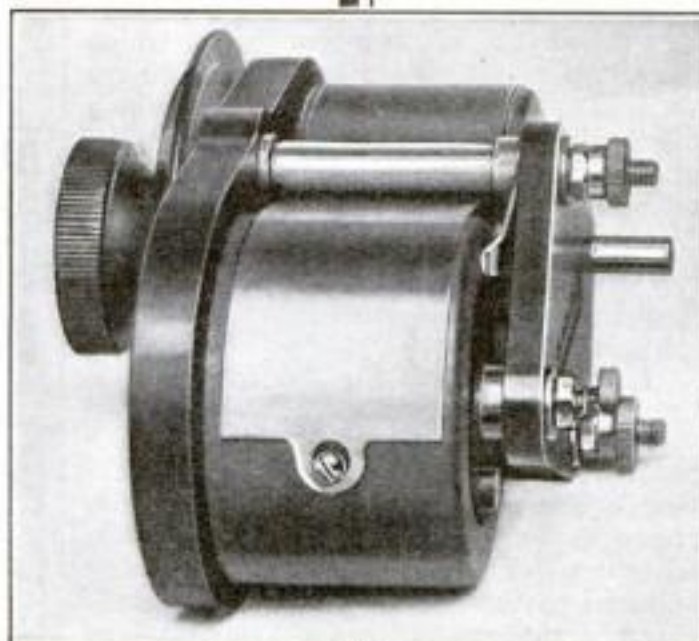
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(Continued from page 24)

were tried in an effort to stop this phenomenon of induction. Queer, mysterious instruments were hung on the poles or connected in the circuits. Some of them not only killed the induction, but they killed the voice currents as well.

Just at the juncture when those assigned to the problem were about to give it up, one of Carty's men tried the simple expedient of twisting the two wires of a circuit about each other. It worked! Troublesome induction was eliminated and the telephone company was enabled to extend its lines a little farther.

These extensions, however, presented other new problems, one of which was the iron wire, which had been borrowed from the telegraph. A long distance line, built from Boston to New York, was found to be practically unworkable because of the extremely high resistance of the iron wire to the telephone currents. All sorts of iron and steel wire were tested, but to no avail. Experiments with other metals proved that copper was best. But the copper wire then available was so soft that when lines were strung, the copper stretched and broke under its own weight.

First Hard Drawn Copper Wire

As usual, one of Carty's men came to the rescue with the idea that copper might be drawn into a hard wire. This man was sent to a Connecticut wire factory where, after a series of experiments, he produced one of the fundamental contributions to modern communication—the hard drawn copper wire. This wire combined the electrical advantages of copper with the strength of iron, and at the same time it eliminated the rusting of wires.

The one drawback to copper wire proved to be its high cost—four times as much as that of iron. In some instances, on long lines, it was necessary to use wire as thick as your finger. The first line between New York and Chicago (a single circuit), for instance, weighed 870,000 pounds and the cost of the bare metal was \$130,000! How might this cost be reduced?

Carty and his staff supplied the answer by discovering better kinds of insulation, by making telephone instruments more sensitive, and by the use of a new invention called the "loading coil," all of which permitted smaller sizes of wire. The invention of the so-called loading coil, which eventually made transcontinental telephony possible, came from outside the telephone industry. It was the work of Michael J. Pupin, professor at Columbia University, and it saved as much as \$40 for each mile of wire.

Early Days of the Switchboard

In 1885 began the development of the modern switchboard. The first switchboards, like other parts of the first telephone system, were borrowed from the telegraph. They connected only a few hundred customers, but occupied as much space as the modern switchboards, where one girl can now make connections between any two of 10,000 subscribers.

As the number of telephone subscribers increased, the size and complexity of the central office equipment grew at an alarm-

(Continued on page 111)

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(Continued from page 110)

ing rate—so alarming, in fact, that at one time the general manager of the New York office actually prepared figures showing just how many new subscribers would be required to throw the company into bankruptcy! Sometimes a single switchboard would cost several millions of dollars.

Again it was up to Carty and his co-workers to find a remedy. And they found it, but through the slower, surer course of scientific research. Under his guidance one new type of switchboard after another was devised and tested. Long before one switchboard wore out, it was replaced by improved apparatus.

Machines that Seem to Reason

Deliberately, each small step in the progress of wired communication led surely to the crowning achievement of the modern telephone — the automatic switchboard, with which a telephone user can make his own connections without the intervention of any other human hand or brain. These marvelous automatic machines not only make connections between two parties on the same exchanges, but select "trunk" lines between exchanges that are not busy. They operate coin box stations with accuracy as to charges, returning coins, and perform with accuracy a hundred other functions that a telephone operator can perform only after a long course of training. They are now being installed in all parts of the country as rapidly as they can be manufactured and put in service.

Still another problem solved by Carty's telephone engineers, was the underground cable. When the telephone was young, wires were strung along the housetops. Soon this plan had to be abandoned and the wires were put on poles. But in the cities the pole lines became so crowded that it was practically impossible to string more wires. Finally, legislatures and city councils began to demand that the wires be taken down and placed underground.

Of course, it was possible to bunch the wires in cables and put them underground, but they wouldn't work there. Difficulties of transmission were increased a hundred-fold. Induction and resistance at once became so great that it was easier to talk over 100 miles of open wire line than over one mile of cable.

Evolution of the Cable

At first the wires of the cable were embedded in rubber, and while rubber was a good insulator for most purposes, for some reason it destroyed the delicate voice currents. To quote Carty:

"Cable was expensive; the distance over which one could talk was limited, and nobody knew what to do about it. As early as 1881 I participated in experiments in which all possible types of cables we could think of were put down. The first big advance was the introduction of cotton insulation in the cables instead of rubber. The cotton cable was very greatly improved and finally it was superseded by the paper cable, in which each wire is wrapped loosely with paper. The paper cable has gone through a process of evolution until today we have cables no larger than your wrist carrying 3000 wires, and our cable

(Continued on page 112)

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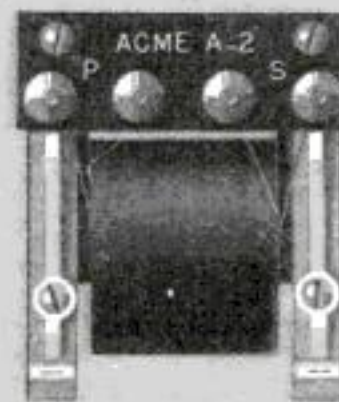
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Chief of the Greatest Telephone System

(Continued from page 111)

lines extend from Boston to Washington, and from New York halfway to Chicago. There is now no physical difficulty in the way of cables from coast to coast."

In spite of all these remarkable developments, it would still be impossible to send weak telephone currents across the continent and receive them with sufficient strength to be audible, were it not for the invention of the telephone repeater. The function of this ingenious instrument is to pick up the weakened telephone current at a point along its route, strengthen it, and send it on to the next section of line.

The average radio amateur will at once recognize the telephone repeater as the familiar vacuum tube amplifier. That is exactly what it is, although it is not generally understood that the vacuum tube was developed in the telephone laboratory.

Original Use of Vacuum Tube

When Dr. Lee DeForest invented his vacuum tube, Carty and his staff were the first to see its far-reaching possibilities. Today, thousands of vacuum tubes, as perfected by countless researches of the telephone engineers, are in service 24 hours a day. A telephone conversation between New York and San Francisco is relayed 12 times through vacuum tubes, yet the voice heard at the distant end of the line is a faithful reproduction of the speaker's words!

Not only the vacuum tube, but the wireless telephone itself as a reliable means of long distance communication, was born in the telephone laboratory under the guidance of Carty. As early as 1913 Carty had set a scientific staff to work investigating the use which the telephone system might make of radio. As a result, a practical wireless telephone was developed and in one experiment with this instrument Bell engineers talked from the Arlington station to the Eiffel Tower in Paris. One engineer even picked up the conversation in far-distant Hawaii—a long distance record that never has been broken.

We have here but the barest outline of the marvels of the telephone, for there are hundreds of other devices about each of which a book might be written; for example, the phantom circuit, which makes two pairs of wires do the work of three pairs; the carrier current system by which six or seven simultaneous conversations may be carried on over the same wire; the multiplex telegraph, by which several telegraph messages can be sent over a wire being used simultaneously for one or more telephone conversations.

Today there are more telephones in New York City than in all of England; Chicago has more than France and nearly as many as Germany. With one sixteenth of the world's population, the United States has one third of the world's telephones. In this country every year there are 350,000,000 more long distance telephone calls than telegrams and 6,000,000,000 more telephone calls than communications by letter.

These achievements of the telephone would never have been realized except by the constant application of scientific research, and among the exponents of the practical value of science there is no one more conspicuous and successful than J. J. Carty.

Coué's Magic Health Secrets

(Continued from page 26)

the simple and unspectacular act of hitting the ball straight or doing the week's work easily and right.

Prove this to yourself. You know that you can easily stand on a foot-square platform two inches above the floor—but all the will in the world could not make you stand safely on the same platform suspended in space 300 feet above the gorge of Niagara. The reason is simply that if your imagination avidly seizes on the spectacular picture of the fall in store for you, your will, unless under marvelous control, cannot prevent the unconscious from absorbing this picture, and the unconscious, through its mysterious action on the functions of your body, promptly precipitates the fall.

To apply the Coué system you need only a few brief recipes. First, you must be convinced that cure by autosuggestion is actually possible. You must have faith. The experiment illustrated on page 26, and suggested by C. H. Brooks in "The Practice of Autosuggestion"—one of the most readable explanations of Coué to be had—will convince you of the powers of the unconscious. Brooks also cites the familiar trick of telling a passenger on a ship that he looks as though he were getting seasick. His imagination is already full of the terror of this very development. Your word reinforces the terror and he succumbs. But turn to an old time seaman and tell him the same thing, and he merely laughs. His unconscious doesn't accept the idea, and the same suggestion has no effect upon him.

Is Coué's Personality a Factor?

While Coué claims no power of any kind not inherent in all of us, it is probably true that a slightly hypnotic effect, due to his personality, impresses his hearers, and so overcomes their first conscious revolt against his theory and influences the unconscious mind to accept the message he has for it. Thereafter, the whole process of cure becomes one of purely self-suggestion, that anybody can practice.

Of course, you must not expect miracles. Coué and his disciples have published hundreds of testimonials of cures for practically all the diseases that can afflict a human being. That many of the cures claimed are utterly absurd and absolutely impossible has been proved by the experience of generations of scientific observers, who have studied the very methods used by Coué and his followers.

Autosuggestion may cure only where the disease or the disorder is due to abnormal functioning of the nervous system, or to abnormal functioning of an organ, the operation of which can be influenced by suggestion through the nervous system.

All conditions that can be improved or eradicated by stimulating better digestion, assimilation and nutrition, or that respond directly to strong mental stimuli, can of course be helped by the Coué formula. But these do not include tuberculosis, diphtheria or any organic disease or acute germ infection. Germs that are alive and kicking won't pay much attention to hypnotic suggestions or even the Coué rosary string.

But science must accept the fact that functional and nervous disorders will often succumb to autosuggestion and that Coué's sudden worldwide fame is justified because he has brought us a novel technique for effecting such cures.

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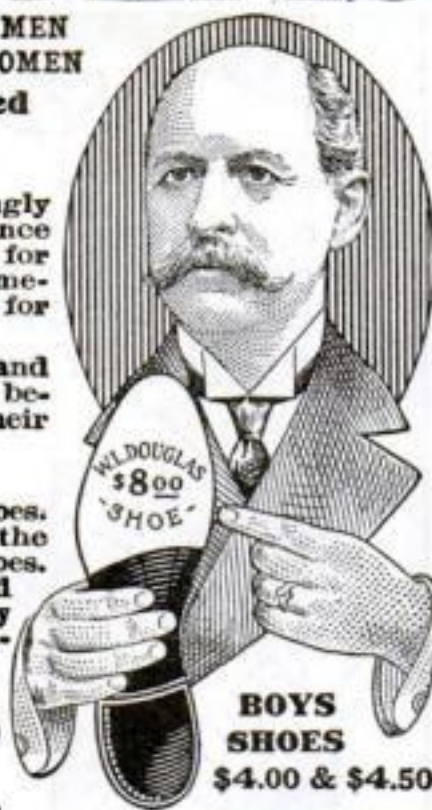
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The First Successful Color Movie

(Continued from page 61)

photograph made through the red-orange screen. They will not show on the other photograph. The blue parts, on the other hand, take only through the blue-green screen. Now we dye one photograph red-orange and the other one blue-green. The first represents the red parts of the dress, the second the blue parts. We put them together, one on top of the other (of course both are transparent), and we have a color photograph of the dress.

All this is simple enough, but when we come to apply it to motion pictures, there are difficulties. The greatest is to discover some way of taking two photographs at the same instant, *through the same lens*.

This problem Doctor Comstock solved in a very ingenious way. Just back of the lens of the camera he placed a silver mirror with holes in it. Half of its surface is polished silver, the other half is holes. It stands at an angle of 45 degrees to the beam of light. What happens to the light can be seen immediately from the diagram on page 59. One half of the light is reflected at a right angle. The other half goes straight on. The light beam from the lens is thus split into two beams, exactly alike. One of these beams is led through the blue-green color screen, to make the blue-green image at one point on the film. The other is led through the red-orange screen and makes the red-orange at the same instant on a lower portion of the film. Then the film moves and two new images are made again, one above the other.

The film consists, then, when removed from the camera and developed, of a succession of double pictures (one below the other) all still in black and white. One picture of each pair corresponds to a blue-green image, the other to a red-orange image. This film, of course, is a negative.

The next step is to make the positive print from this negative. On this print the pair of images taken at the same instant and that are separate on the negative must be brought together and superposed. The blue-green one of a pair is printed on the front of the positive film, the red-orange one is printed on the back of the same film. They must now be dyed.

In this process the positive film is run through one dye bath that contains in solution the blue-green dye and the red-orange dye. The dyes are taken up selectively by the two images on the film; the blue-green dye "takes" only on the blue-green image; similarly, the red-orange dye colors only that image.

The result of this selective dyeing is a colored positive print ready for projection.

Aside from the technical difficulties involved in the perfection of color movies, there remain other still more interesting problems—problems of directing, of acting, of the psychology of audiences. At present the movie actress's make-up, for instance, is a horrible looking mess of yellow cheeks and blue chin and forehead; blues for what is to be white, yellow for healthy flesh. For color movies all this must change.

An effective make up, I believe, may prove to be greenish or violet, with reds inclining to orange, instead of the yellows and blues now used. Certainly, when the color movie make-up technique is so perfected as to simulate a beautiful star's natural color of complexion, hair and eyes, we shall have more fascinating photo plays than ever.

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THE HOME WORKSHOP

Box for Feeding Birds in Winter Turns with the Wind

By Robert Page Lincoln

TO ENCOURAGE the winter birds in the colder sections of the country, many persons scatter crumbs or seeds on the ground, after clearing away the snow. This is not the best method, because driving snow frequently covers the food just at the time when it is most needed. If a revolving



feed or bird box is provided, this difficulty will not arise.

The type of pivoted box illustrated is one that has been used with success. It can be made of $\frac{1}{4}$ or $\frac{3}{8}$ in. stock in any reasonable size. The wings are of the same material, cut as shown. The house revolves on the end of a pole that has an iron rod driven into it. A washer is used between the top of the pole and the bottom of the house.

The box should turn readily in a high wind, but not so freely that it has a tendency to spin.

A Simple Set Line Rig for Winter Pike Fishing

A THOROUGHLY reliable method of making a set line rig for fishing through ice for pike, muskallonge and other large fish, requires nothing more than a stick and crotch. The crotch is large or small, depending upon the amount of line to be used.

A hole is bored near the top of the handle and the line is pulled through, brought down to the crotch, slipped under and then wound over one arm and under the other. This over and under winding is continued until all the line is on the crotch except the length desired to hang. Thus, for fishing in 20 ft. of water, with the lure 5 ft. from the bottom, it is necessary to allow 15 ft. of line to hang free. The line is secured by slipping it into a slit cut in one arm of the crotch.

The lure is a live minnow or a 6-in. perch. It is dropped down and the whole crotch is suspended from a rod by being tied to a pole across the hole. When the pike seizes the lure, it pulls the line out of the slit; and as the fish runs, the line slowly unwinds. If there is 50 ft. of line on the crotch, the fish will be well tired out when he has taken it all off. Set lines of this sort are put out in the afternoon of a winter day and looked after the next morning.—L. R.



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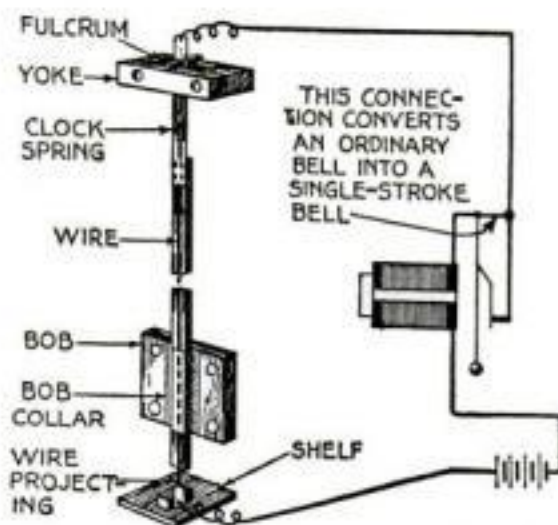
Electric Timer in Darkroom Aids Amateur Photographer

By H. C. McKay

IN ALL darkroom work the amateur photographer feels the need for some method of accurately counting time. Consulting a watch or guessing at the time are equally unsatisfactory. The ideal way is to make a simple audible counter.

The materials required are a common advertising yardstick, a 6-in. length of light clockspring, a wooden block 1 by 3 by 3 in., some tinner's lead or babbitt, wire, batteries, a large nail or spike and an electric bell.

The ends of the clock spring are annealed. Through one end is drilled a hole just large enough to admit the spike; through the other, four small holes are drilled for fasten-



When the pendulum is properly adjusted, the bell rings once a second

ing it with screws to the yardstick. The nail is then cut down to about 3 in. long, and filed at each end to form a wedge, as shown. The piece is then soldered to the clockspring, with the sharp edge of the wedge turned down. From this fulcrum to the bottom of the yardstick should be at least 41 in. A wire is next soldered to the end of the spring, carried down the stick and allowed to project an inch or two. A sliding weight is made by boring several holes into the wooden block and filling them with babbitt and the block is fastened to the yardstick with a tin strap fitted tightly. Thin wedges may be used to fasten it in the exact position that will cause the pendulum to swing 60 times a minute.

A yoke is then made, as shown, and fastened at a convenient place on the wall. A small shelf is placed just below the bottom of the wire projecting from the lower end of the pendulum. Upon this shelf is fastened a thin strip of flexible copper such as may be obtained from a field coil of a Ford magneto. This strip should extend upward, so that the swinging end of the pendulum will just touch it. All that remains is to complete the bell circuit by attaching one wire to the top of the pendulum spring and the other to the copper strip. If the bell is wired as shown, it will give a single stroke, which is desirable.

A small cup filled with mercury may be substituted for the copper strip. The surface tension of the mercury allows it to "pile up" over the edge of the cup so that the wire can swing through it. This gives less obstruction to the passage of the wire, but each swing scatters a small amount of mercury and the cup has constantly to be refilled. Another refinement is the substitution of a telegraph sounder for the bell. This is the form I use.



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THE HOME WORKSHOP

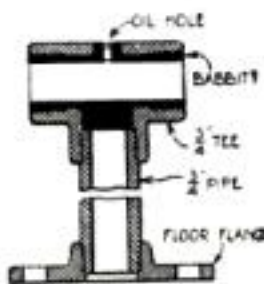
Motorizing Your Workshop

(Continued from page 77)

pulley arrangement for starting and stopping them. A double belt arrangement will also give a reversing pull when tapping or cutting threads.

For the general utility shop and the farm repair shop the installation can profitably be somewhat heavier, with floor machines, commercial hangers, and light steel pulleys as shown in Fig. 2, page 77. This layout for the handy man's motorized workshop provides for a saw bench, grindstone, grinder, and post drill.

Those who plan to install machinery in a basement or cellar should avoid fastening hangers to the floor beams, since the vibration will be felt throughout the house. The hangers should be attached to cleats fastened to the masonry with lagscrews and expansion shields. The hangers should be deep enough to take a pulley at least 30 in. in diameter, which obtains the speed reduction from the motor pulley.



A pipe tee heating

For the home shop, shafting 1 in. in diameter is heavy enough, and for light machinery a round belt offers one of the handiest means of transmitting power. Round belts and pulleys can be obtained in many junkyards from wornout sewing machines and the like, and often flat belt pulleys can be obtained in the same way. Cold rolled machine steel serves for the shafting, and the babbitt bearings can be cast by the builder himself.

The outfit shown in Fig. 3, page 77, is a good one for the home worker who specializes in machine work, model making, and the like. The bench arrangement illustrated provides a compact and very useful small machine shop with bench lathe, miller, drill press and grinder.

Some Hints about Machine Tables

Machine tables or workbenches can be made by the home mechanic to suit his own requirements and should be strong and heavy. If the bench is too light or flimsy, the vibration of the machine is bound to be troublesome. If possible, the bench should stand from the wall, so that the operator has access to all sides. The motor wires can be strung from the floor or dropped from the ceiling. At least two switches, one on either side of the bench, should be provided for starting and stopping the motor.

Motors up to and including $\frac{1}{4}$ hp. can be tapped off the electric light current, but $\frac{1}{2}$ hp. must have a separate wire from a power circuit. A good arrangement is to have a three-way socket mounted overhead, the top of one side being used for the motor, another side for a portable electric drill, and the third side for the light.

The problem of countershafts and tight and loose belts can be avoided if one is willing to throw off the idle belts on machines that are not in use. This saves in equipment and lightens the load on the shaft.

Before buying a motor, it is well to consult an electrician in regard to the correct voltage, phase, and cycle of the power available. If electric current cannot be used, a small gasoline engine will give dependable and inexpensive power.

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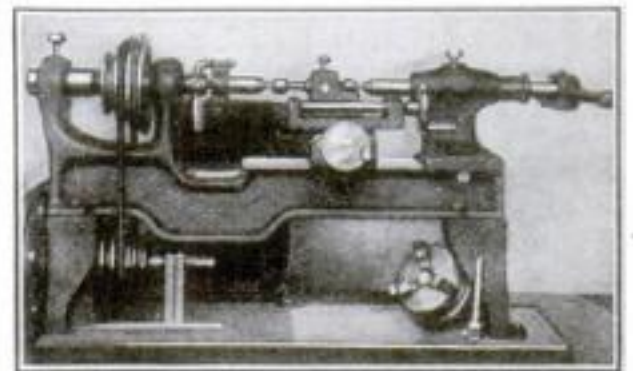
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THE HOME WORKSHOP

Motor Drive for Bench Lathe Takes Up Little Room

By Howard Greene

AMATEUR mechanics like the writer are often put to it to find room for their tools and equipment, especially in the constricted space of a flat. While an old table in the corner of a bedroom has done duty as a bench, it was a problem to make a place for a diminutive lathe that was added to the outfit. The lathe itself is but 13 in. long and swings 4 in. over the bed and 5 in.



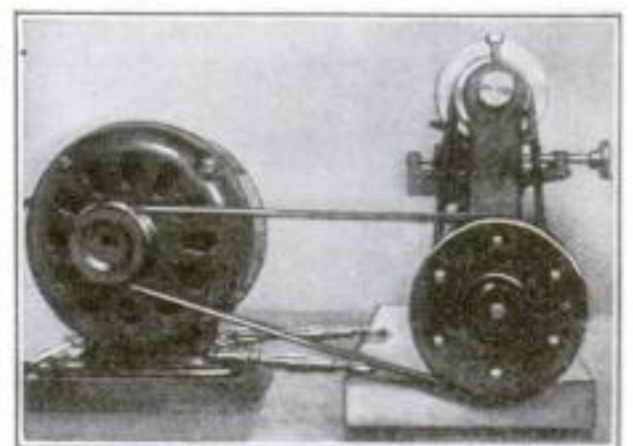
A countershaft for the motor drive is placed under lathe bed

in the gap, but there seemed no place to put a foot power drive, so the lathe had to be motorized.

Experiments were made with a number of small motors. Motors that formerly had done duty driving fans were found unsuitable because of the variable speed. Very small motors were available, having plenty of power despite their compactness, but they were unsatisfactory because of their very high speed, which necessitated a lot of speed reducing gearing.

Finally an induction motor rated at 1/20 hp. was installed. The power is exactly right, being sufficient to drive the lathe under all conditions of work, and the speed is absolutely constant at 1750 r.p.m.

The lathe was mounted on one piece of oak $1\frac{1}{2}$ in. thick and the motor on another. The bottom of both bases was padded with



Turnbuckles connect lathe and motor bases and regulate the belt tension

heavy felt glued on. The two bases were then connected with turnbuckles set at an angle, so that the lathe and motor cannot get out of alignment. The turnbuckle also serves to regulate the tension of the round driving belt, which is $3/16$ in. in diameter.

The pulley on the motor is $1\frac{1}{2}$ in. in diameter and drives a 4-in. pulley on a countershaft set under the lathe bed. The three-step cone pulley on the countershaft is a duplicate of that on the lathe spindle, except that it is made of fiber disks screwed together. The outfit is shoved out of the way when not in use.

The difference in the electric light bills made by the use of the motor is so slight as to be negligible.

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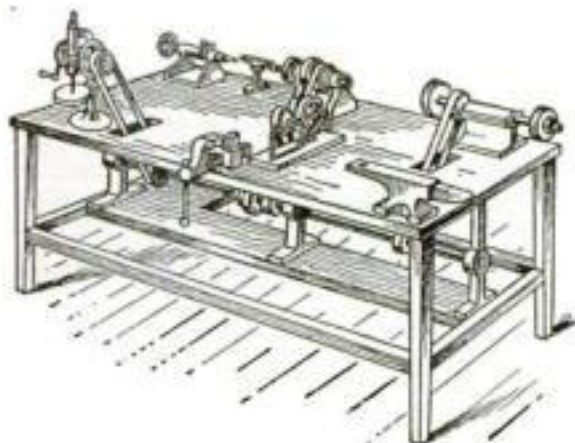
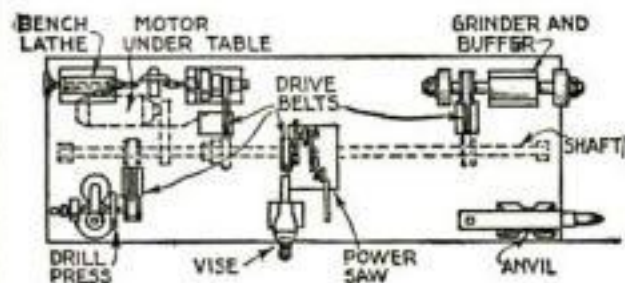
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THE HOME WORKSHOP

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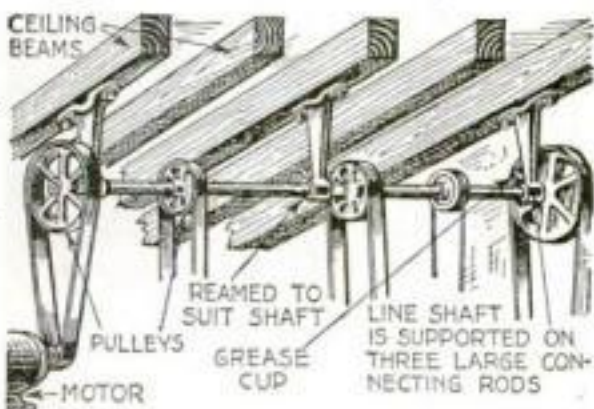


A miniature machine shop with motor and shaft mounted on shelf under bench

shafting. A drill press, a power hacksaw, a bench lathe, a combined grinder and buffer, a small anvil, and a vise are bolted to the top of the bench. The hacksaw is so placed that material to be cut can be clamped in the vise.—G. M. D.

Connecting Rods Serve as Hangers for Line Shaft

THREE large connecting rods from an old engine were utilized by a Washington, D. C., mechanic for supporting a line shaft that was to drive a series of small bench machines from a 1-hp. electric motor. The 1-in. shaft extends for 15 ft. across the



Hangers cost little to install

shop and improvised hangers are placed at 5-ft. intervals.

The large end of each connecting rod was attached to the beams with heavy lag screws and the bearing at the small end of each was reamed to suit the shaft and fitted with a grease cup. No loose pulleys are used on the line, but an electric switch conveniently located permits throwing the power off and on as required.—L. F. B.

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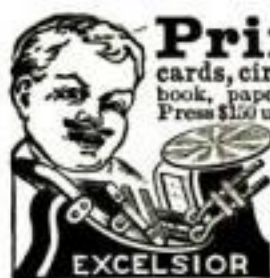
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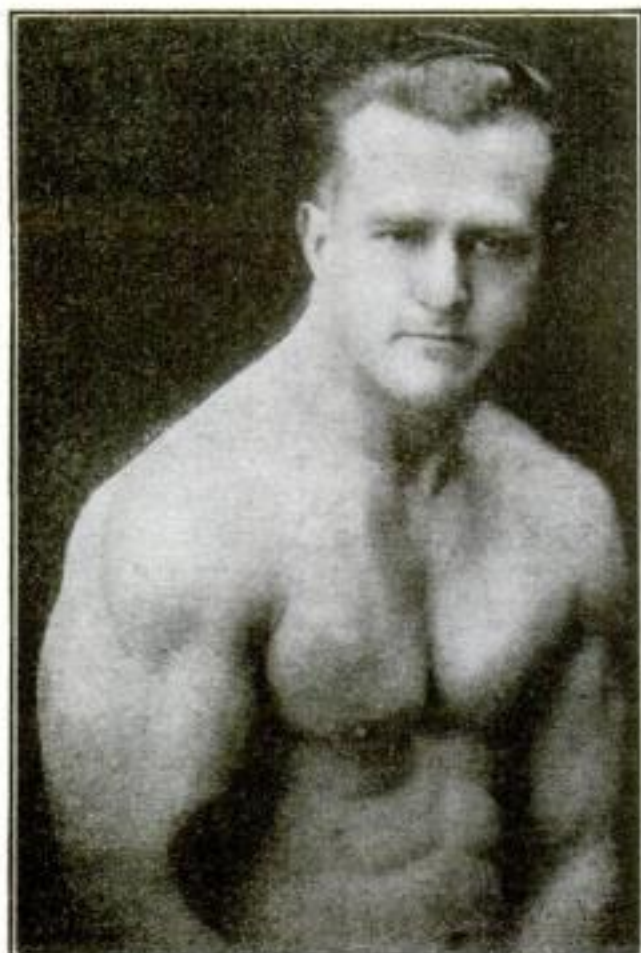
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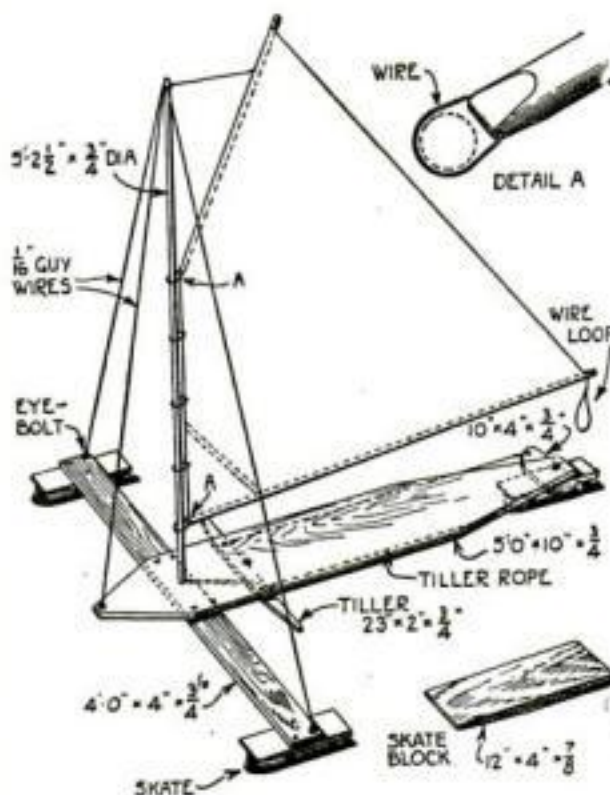
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THE HOME WORKSHOP

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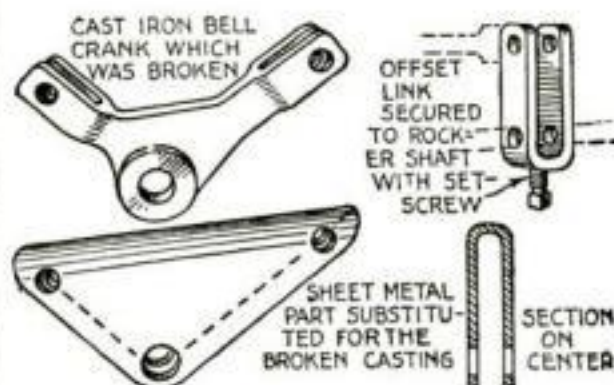
loop at the end of the boom, which is slipped over either ankle.

The sail may be lowered in the usual manner and the boat can be dismantled by folding the spars parallel to the mast and removing the mast from its socket. Hockey skates are screwed to the runner blocks. The illustration makes clear all other details.—DONALD W. CLARK.

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These simple substitutes prevented tedious delay in obtaining new parts

nections to the lower draft door at the rear of the furnace had been broken, but the need for a new casting was avoided by making the sheet metal substitute that is illustrated. The piece was doubled at the center and drilled for the rocker pin.

Another repair was made by using a strip of steel and a setscrew to replace an offset link that had been connected with the rocker shaft.—L. N. O.



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THE HOME WORKSHOP

Wind Drives Ice Bicycle

(Continued from page 78)

justing them where desired on the rear wheel trusses.

All the details of the scooter attachment are illustrated, but the materials and parts can be varied to suit the convenience of the maker. The dimensions shown are intended to meet normal needs. For racing, a larger spread of sail and narrow, grooved runners are improvements that add to the speed, but call for skill in manipulation, particularly at turns.

As a final detail, some gripping device is desirable on the rubber-tired wheel. Sash chain or very small size tire chain may be used. To apply sash chain, wrap it around and around the tire for one revolution of the wheel and then wrap it in a reverse direction to give a diagonal cross-linked surface, as shown on page 78. Small tire chain is more difficult to apply because the sections must be much reduced to suit the bicycle tire.

Carved Strips Transform Cigar Box into Jewelry Case

ORNAMEN-
TAL carving of the simplest kind will transform an almost square cigar box into the jewel case illustrated.

The carving is done on strips taken from another cigar box, some of the strips being 1 in. and others 1/2 in. wide. Each of the strips is then notched along its two upper sides with a pocket knife, care being taken to space the notches



How simple workmanship evolves the case shown above

equally as to depth and width. Then, when a sufficient number of strips have been cut, the wider ones are nailed along the outer edges of each side and top. Over them the narrower strips are bradded until all four sides and top are finished.

The ornamentation may be carried further, if desired, by placing notched strips or plates in the center of each side.

After being sandpapered, stained, and waxed, the box appears to be carved from solid wood.—ERNEST BADE.

Keeping the Windshield Clear

THE difficulty of keeping the windshield clear in a rain or snow storm can be overcome by washing it with a mixture of one part kerosene and one part glycerin shaken well together. The kerosene acts as a cleanser and the glycerin as a coating over the glass, from which the moisture will run without blurring the driver's vision.—H. G. KEBEL.

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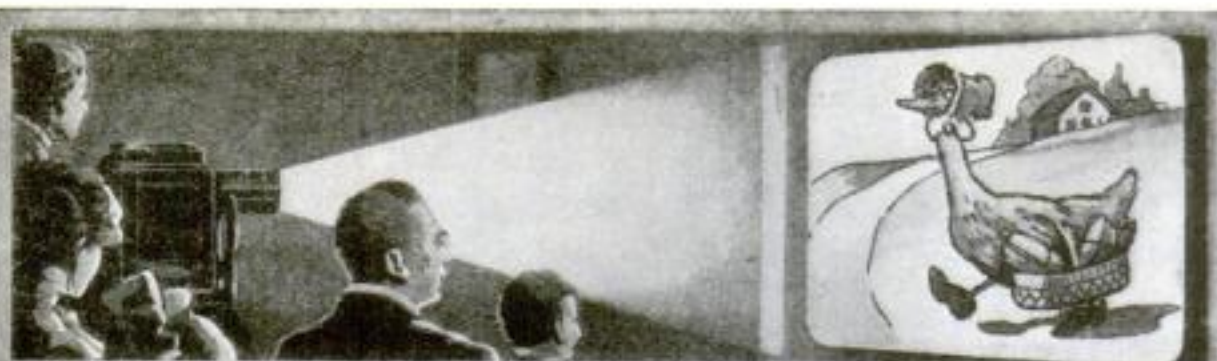
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THE HOME WORKSHOP

The Secrets of Stenciling

(Continued from page 78)

and original designs that do not require to be filled in with a brush.

Paper for cutting stencil should be rubbed on both sides with linseed oil and turpentine to make it tough and easy to cut, or prepared stencil boards may be purchased.

After drawing or tracing the design on the prepared paper, lay it on a glass slab and take great pains to make a clean cut and not to run past the outline of the design. This is best accomplished by using a short pointed knife, preferably sharpened on both edges, which may be bought at any cutlery store. The majority of stencil cutters, however, make their own knives to suit and often use a safety razor blade in a homemade handle, as shown in Fig. 3.

Suppose it is desired to stencil a black Greek border on a yellow flower box, as at I, page 78. The first thing to do is to draw



FIG. 3.
Stencil knife made from razor blade

the figure and determine how many of these figures, or repeats, as they are called, are required for the given field. The repeats are in black at E, F and H, page 78.

Assume the box to be $19\frac{1}{2}$ in. long, $10\frac{1}{2}$ in. wide, and that the repeat is $1\frac{1}{2}$ in. long; 40 impressions will then be necessary to go around the box. The work will be greatly facilitated by cutting out more than one repeat; say three, thus making the stencil repeat $4\frac{1}{2}$ in. long, as at A. A single unit B then finishes the $19\frac{1}{2}$ -in. side. Mark divisions on the stencil, as at G, by drawing two vertical lines, and at the end of each line cut a V notch for locating. Trim the stencil so that it will not cut any portion of the design when applied, as otherwise, if the paint is still wet, it will blur the preceding work. It is, however, advisable to use a flat or fast drying color.

Brushing on the Color

When there is a large surface to cover, it is best to strike a center line with a piece of cord that has been rubbed against chalk or charcoal. It should be held taut at each end and snapped against the work. Also indicate the center line on the stencil.

Match the stencil accurately on the marked divisions, hold it firmly against the object, then barely dip the stencil brush into the color and rub off the surplus on a piece of waste paper. Hold the brush at right angles to the stencil and move it around and around over the cut parts as though grinding a mixture, as otherwise the hairs will get underneath the stencil and blur the design. It is well to have stencil brushes of various sizes on hand. They should be very closely bound with thin ferrules reaching almost to the tip. These can be had only at a paint store.

After straight line figures and the use of one color have been mastered, no difficulty should be experienced with more elaborate designs and the use of more than one color.

For the ceiling design J, Fig. 2, page 78, circles drawn with a compass give the working basis. The center dots may be punched

(Continued on page 123)

THE HOME WORKSHOP

The Secrets of Stenciling

(Continued from page 122)

with a punch on a block of wood. Section the ceiling to suit the stencil.

It is readily seen that if the design is in two colors, a much prettier effect can be obtained. Two stencils may be cut, one for each color, although if the design is very simple and open, the stenciling may be done with one stencil, or that part of the stencil representing one color may temporarily be covered with a mat. In this way two or more colors may be applied with one matching. The coloring should be rather light. If, for instance, the ceiling is a light bluish tint, the four-pointed ornament might be light brown and the crest light gray, but any combination of colors may be used as long as they harmonize.

A border or frieze should be somewhat larger and bolder, or more masculine, as it is termed, than the wall pattern, but it still should harmonize with both the wall and ceiling design.

When Designing a Frieze

To draw the conventionalized frieze shown at K, on page 78, erect a vertical line and draw half the design, then trace it on a separate piece of tracing paper and transfer it by rubbing with thumbnail or burnisher to the other side of the line, thus completing the figure.

A wall pattern arranged in the form of a step, that is, so that the repeat takes a step each time, as it were, is an arrangement frequently used. If combined with other ornamentation, as in this case a spray, L, care should be taken that the design as a whole is evenly spaced. This is best accomplished by making a few trials to determine the proper location.

The general arrangement for the color scheme is as follows: the ceiling rather light, the wall pattern a shade or two darker, and the frieze a trifle darker than the wall pattern, or else the base may have a conspicuous color.

Gold or gilt decoration on furniture harmonizes with nearly all surroundings and is easily put on. Suppose it is desired to gild a neat border around a polished mahogany table, as at M. In this case the ledge will act as a guide and the stencil should be cut accordingly.

Furniture Stencils in Gold Leaf

Obtain a can of gold leaf size, a book of gold leaf, and a gold leaf tip, which is a wide brush for picking up the gold leaf. In order to prevent the gold from sticking all over, a tendency it has on polished surfaces, cover the part to be stenciled with pounce or pulverized chalk, using a soft cloth; then stencil the design with size, allowing it to stand as long as directed, or until it is just sticky enough to hold the gold leaf. Cut a portion of gold leaf with a knife or the point of a finger nail. Brush the tip lightly across your hair to oil it sufficiently to hold the gold leaf, and then lay the leaf carefully on the sized design. Brush off with a soft piece of cotton, being sure that no part of the design has been missed.

Another use for stencils is for centerpieces, draperies, and the like. A one-color effect, especially a medium blue, mixed with japan dryers, is often appropriate for muslin. The repeat for a centerpiece design is shown at N.



Claude L. Yates



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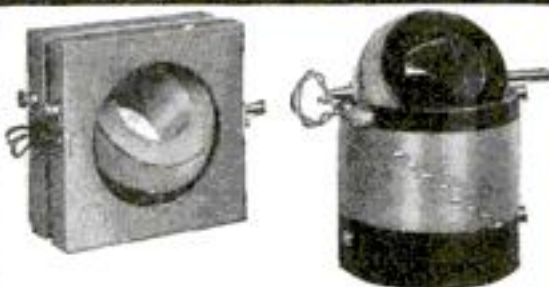
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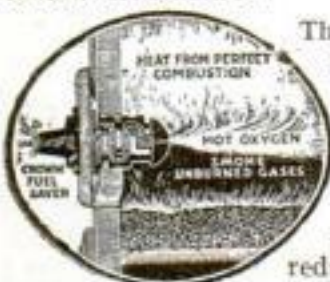
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The Shipshape Home

How To Do the Odd Jobs

Mending China

don't fail to pick up the pieces. To cement them together you can use nothing better than ordinary white lead, according to comparative tests made by the Department of Agriculture. The white lead may be bought in a small can at the paint store or in a tube, in which form it is put up for artists' use. It may be rubbed with the finger on the raw edges of the dish and the piece which is to be cemented into place, but it is well to rub down the edges a very little with emery cloth beforehand to make room for the thin layer of white lead, so that the dish when completed will not be distorted in shape. Care should be taken not to use too much white lead.

Melted sealing wax is dropped here and there on each side of the seam to hold the piece or pieces firmly in place. The dish should then be set away and left for eighteen months or two years to give the white lead time to harden thoroughly. At the end of that time the sealing wax can be picked off and the seams carefully scraped to remove any excess of white lead. A dish so repaired will stand washing and reasonably careful handling.

Professional china menders use rivets of silver or copper wire in addition to a cementing process. If a dish is valuable or particularly prized, an expert can often supply missing pieces, restore the design, if necessary, and glaze the piece.



Patching Dishes

too large. Plaster of Paris is worked up with a good quality of liquid glue or other liquid cement until the mass is as stiff as putty. Work some of the material into the space to be filled, mold into place, and rub with a wet fingertip until smooth. The material used acts as its own cement.

When the plaster of Paris is perfectly dry, it may be tinted with artist's oil paints to look like the rest of the dish, and with a little care any interrupted design may be continued or replaced. Over such painting as this, when it has thoroughly dried, it is well to apply a coat of light-colored waterproof varnish or enamel.—S. R. WINTERS.

Cleaning Painted Walls

SCRUBBING painted walls with soap or soap compounds is a long and tiresome task and often leaves the surface more or less streaked. Some spots appear unusually clean because the soap has been left on them longer than at other places.

An old painter, in giving advice as to the

(Continued on page 125)

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give quick relief

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BE COMFORTABLE—Wear the Brooks Appliance, the modern scientific invention which gives rupture sufferers immediate relief. It has no obnoxious springs or pads. Automatic Air Cushions bind and draw together the broken parts. No salves or plasters. Durable. Cheap. Sent on trial to prove its worth. Never on sale in stores as every Appliance is made to order, the proper size and shape of Air Cushion depending on the nature of each case. Beware of imitations. Look for trade-mark bearing portrait and signature of C. E. Brooks which appears on every Appliance. None other genuine. Full information and booklet sent free in plain, sealed envelope.

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THE HOME WORKSHOP

The Shipshape Home

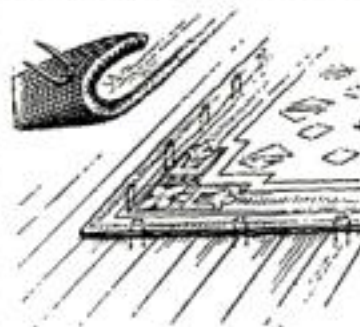
(Continued from page 124)

best way of cleaning the paint on walls that were coated with smoke and grime, suggested the use of gasoline applied with a heavy woolen rag. When the walls were cleaned in this way, the surface came out clean and clear; the color of the paint was revived, leaving it free of streaks and spots. Through the use of gasoline, the crevices and corners were cleaned without much effort, as it seemed to penetrate and loosen the dirt.

Try this method on any painted wall for quick results, but be careful to keep fire away and the windows open for several hours to get rid of the fumes.—A. L.

Tacking Down Rugs

household. To keep the edge in place, take a short, double-pointed tack or staple, pass one point up into but not through the



rug from the bottom, turn it and bring it out at another place, so that the tack is well caught in the rug below the surface, as shown. Several more tacks are inserted in the same way along the curled edge and they are then driven into the floor. If the tacks are close together, they will hold the most stubborn edge in place.—LEROY WHITMAN, Washington, D. C.

Making Roofs Tight

be brushed on with a stiff bristle three-knot brush. The coat should be 1/32 in. thick or thicker.

All open seams or loose composition shingles should first be closed with a plastic roofing cement and especial care should be taken to repair worn out, broken, or corroded flashings. When necessary, use patches of tin, galvanized iron, prepared felt or rubberized roofing, stuck on with a thicker layer of cement. This should be done before applying the finishing coat of roofing paint.—M. L. T.

Repainting Old Work

blistering, one coat only should be used, unless it is desired to change the color to such an extent that one coat will not be thick enough to conceal the old finish.

If the old paint is blistered, all the loose parts should be scraped, and if it is in very bad condition, it should be removed entirely.

In two-coat work over old paint, thin the first coat with 1 pt. of pure turpentine to 1 gal. of paint. In repainting with one coat, add 1/2 pt. of turpentine to each gallon.—J. U.

They accused him of cleaning his pipe

But he pleaded not guilty; he had merely filled it with Edgeworth

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Gentlemen:

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Very gratefully yours,
(Signed) Apton A. Brown.

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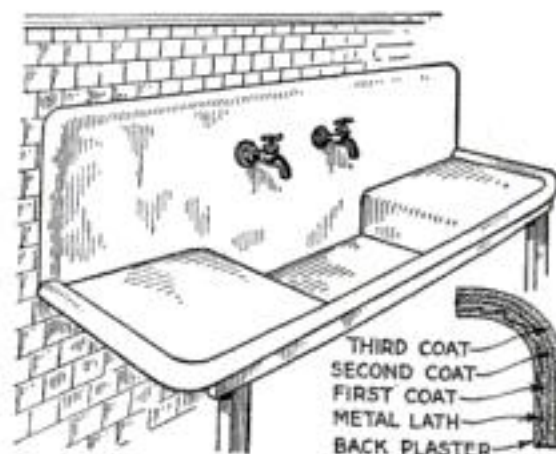
San Francisco, 591 Mission St.

SORSINC

Cement with Waterproof Coating Forms Durable Drainboard

A KITCHEN sink drainboard that costs little and will stand up under constant washing with boiling water and lye can be made of cement plaster on metal lath. The hard surface finish is given with coatings of commercial waterproofing finishes, which are easily obtained and quite inexpensive.

The foundation of the drainboard is made of wood or metal, and a sheet of metal lath is used to reinforce the cement plaster. This



To make this drainboard, cement coatings are placed over metal lath form and a hard waterproof finish is applied

is simply a mixture of 1 part of cement to 3, or a trifle less, parts of fine sand applied just as in any building operation, in 2 or 3 coats of from $\frac{1}{4}$ to $\frac{1}{2}$ in. in thickness. A wooden template can be made to aid in securing the contour of the "rolled" rim.

After the plaster is in place, it is allowed to harden for several weeks. Then it is covered with a waterproof compound that acts on the free lime in the concrete and hardens the entire surface. This is followed by a cement and masonry paint, widely used for covering the exterior of masonry walls. This gives a pleasing finish and is most durable.

One such drainboard has been in constant use for two years and the surface does not show any sign of disintegration.—E. W.

How to Make Your Kodak Look like New

TIME and use play havoc with the appearance of the leather covering of a kodak. The writer endeavored to refinish one with a prepared "camera finish," but found that the slightest moisture caused it to crack and rub off, and a touch of water would wash it off entirely. So a simple process was worked out that has proved highly satisfactory.

The leather is first thoroughly cleaned with a damp cloth. All ragged bits are cut off with a safety razor blade, and the rough places smoothed with very fine sandpaper. Then two thin coats of the prepared finish or any good liquid shoe dressing are applied and rubbed in with a soft cotton cloth. When the finish is perfectly dry, it is gone over with a rag dipped in shellac. This must be done quickly and the shellac applied in a very thin coat, but evenly. Rub in the shellac until it begins to get tacky and catches the rag. Then stop, but give it another rubbing when dry.

The last thing is to apply from one to four coats of ordinary prepared floor wax, liquid or paste, rubbed in hard. An occasional new coating of wax will keep the camera looking like new.—G. H.



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9TRW-9RK-UZP3

THE HOME WORKSHOP

Soda and Salt Solution for
Cleaning Silverware

TARNISHED silverware can be cleaned by dipping it in a solution of water, soda and salt in an aluminum pan. There are several methods of procedure, but the simplest is to fill an aluminum pan that is clean and free from grease with sufficient boiling water to cover the silverware. In the water dissolve the baking soda and table salt in proportions of one teaspoonful of each to one quart of water. Then immerse the silverware until the tarnish is removed.



Dipping the silverware cleanses it without in any way damaging the surface

Rinse the pieces in clear warm water and rub them dry with a soft cloth that is free from dust.

Unless very tarnished, it is necessary merely to dip the silver articles in the solution, but they must come in contact with the aluminum.

The soda combines with the aluminum and in so doing liberates a certain amount of hydrogen. This hydrogen unites with the sulphur that produces the tarnish and passes off in the form of a gas. The silver in the tarnish which remains after the sulphur passes off is redeposited, so that there is no chance whatever, according to silver experts, of this process hurting either silver plated ware or sterling silver. Salt is necessary only when the chemical action does not start readily. Zinc may be used in place of aluminum, and the same action can be obtained by placing a zinc plate in the bottom of an enamel pan.

Silverware that has oxidization or French gray decoration should not be cleaned in this way because the chemical action will clean off the oxidization or French gray with the tarnish.—E. P. Y.

Three Furniture Features
for Next Month

FOR those who are interested in making and repairing furniture, the Home Workshop for March and April will contain a wealth of helpful material. An article telling how to make cedar chests of many varieties, another on the construction of a telephone table and stool, and a third on remodeling old furniture are among the big features for next month.

Articles on painting furniture, also on making "antique" furniture, are scheduled for early publication.



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Ft. Pierre, S. D., Nov. 28, 1922.

Gentlemen:

Just received radio and am very much pleased with it, as it exceeded my expectations. So far have had no trouble in tuning in to most any station. The first night I got Winnipeg, Minneapolis, Chicago, Dallas, Texas, Louisville, St. Louis, Los Angeles, Atlanta, and some station in Oklahoma. The next night I added Kansas City, Davenport, Iowa, and a station in Washington to my string.

These all came in plainly in receiving, but I should like to use a loud speaker, as I am starting a sort of a radio club to help make my payments.

So I am enclosing \$10.00 first payment, for which please send me your two-step amplifier, subject to additional payments of \$5.00 each month until \$55.00 has been paid. I understand that the title remains in your possession until \$55.00 has been paid.

Yours truly,

J. B. Giles.

Groveton, Texas, October 16th, 1922.

Gentlemen:

Inclosed you will find a post office order for payment on my radio machine.

I heard Boston, Mass., last night, the 15th, and Davenport, Iowa, also. I also heard Wichita, Kansas. Please send me a catalog.

Yours truly,

Willie Burch.

Johnston City, Ill.

Harold R. Wakem & Co.,
Chicago.

Enclosed find \$10.00 money order, part payment for the Sensitone Receiver. Here are some of the stations I have already heard with the single detector: PWX-Havana, KOA-Denver, KHJ-Los Angeles, WGY-Schenectady, WBAP-Fort Worth.

Please send me the price of your two-step amplifier for the Sensitone.

Yours truly,

Conrad Cwodziak.

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J. J. B. B. B.

Ready to Battle with the Deep—See Page 5

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Popular Science Monthly

MARCH, 1920
Volume 96-No. 3

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225 West Thirty-ninth St. New York City

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How I Improved My Memory In One Evening

The Amazing Experience of Victor Jones

"Of course I place you! Mr. Addison Sims of Seattle.

"If I remember correctly—and I do remember correctly—Mr. Burroughs, the lumberman, introduced me to you at the luncheon of the Seattle Rotary Club three years ago in May. This is a pleasure indeed! I haven't laid eyes on you since that day. How is the grain business? And how did that amalgamation work out?"

The assurance of this speaker—in the crowded corridor of the Hotel McAlpin—compelled me to turn and look at him, though I must say it is not my usual habit to "listen in" even in an hotel lobby.

"He is David M. Roth, the most famous memory expert in the United States," said my friend Kennedy, answering my question before I could get it out. "He will show you a lot more wonderful things than that, before the evening is over."

And he did.

And as he went into the banquet room the toastmaster was introducing a long line of the guests to Mr. Roth. I got in line and when it came my turn, Mr. Roth asked, "What are your initials, Mr. Jones, and your business connection and telephone number?" "Why he asked this, I learned later, when he picked from the crowd the sixty men he had met two hours before and called each by name without a mistake. What is more, he named each man's business and telephone number, for good measure.

I won't tell you all the other amazing things this man did except to tell how he called back, without a minute's hesitation, long lists of numbers, bank clearings, prices, lot numbers, parcel post rates and anything else the guests gave him in rapid order.

* * * * *

When I met Mr. Roth—which you may be sure I did the first chance I got—he rather bowled me over by saying, in his quiet, modest way:

"There is nothing miraculous about my remembering anything I want to remember, whether it be names, faces, figures, facts, or something I have read in a magazine.

"You can do this just as easy as I do. Anyone with an average mind can learn quickly to do exactly the same things which seem so miraculous when I do them.

"My own memory," continued Mr. Roth, "was originally very faulty. Yes it was—a really poor memory. On meeting a man I would lose his name in thirty seconds, while now there are probably 10,000 men and women in the United States, many of whom I have met but once, whose names I can call instantly on meeting them."

"That is all right for you, Mr. Roth," I interrupted, "you have given years to it. But how about me?"

"Mr. Jones," he replied, "I can teach you the secret of a good memory in one evening.

This is not a guess, because I have done it with thousands of pupils. In the first of seven simple lessons which I have prepared for home study, I show you the basic principle of my whole system and you will find it—not hard work as you might fear—but just like playing a fascinating game. I will prove it to you."

He didn't have to prove it. His course did; I got it the very next day from his publishers, the Independent Corporation.

When I tackled the first lesson, I suppose I was the most surprised man in forty-eight states to find that I had learned in about one hour—how to remember a list of one

Now I can call up like a flash of lightning most any fact I want right at the instant I need it most. I used to think a "hair trigger" memory belonged only to the prodigy and genius. Now I see that every man of us has that kind of a memory if he only knows how to make it work right.

I tell you it is a wonderful thing, after groping around in the dark for so many years to be able to switch the big searchlight on your mind and see instantly everything you want to remember.

This Roth course will do wonders in your office.

Since we took it up you never hear anyone in

our office say "I guess" or "I think it was about so much" or "I forgot that right now" or "I can't remember" or "I must look up his name." Now they are right there with the answer—like a shot.

Have you ever heard of "Multigraph" Smith? Real name H. Q. Smith, Division Manager of the Multigraph Sales Company, Ltd., in Montreal. Here is just a bit from a letter of his that I saw last week:

"Here is the whole thing in a nutshell: Mr. Roth has a most remarkable Memory Course. It is simple, and easy as falling off a log. Yet with one hour a day of practice, anyone—I don't care who he is—can improve his Memory 100 per cent in a week and 1,000 per cent in six months."

My advice to you is don't wait another minute. Send to Independent Corporation for Mr. Roth's

amazing course and see what a wonderful memory you have got. Your dividends in increased power will be enormous.

VICTOR JONES.

While Mr. Jones has chosen the story form for this account of his experience and that of others with the Roth Memory Course, he has used only facts that are known personally to the President of the Independent Corporation, who hereby verifies the accuracy of Mr. Jones' story in all particulars.

Send No Money

So confident is the Independent Corporation, the publishers of the Roth Memory Course, that once you have an opportunity to see in your own home how easy it is to double, yes triple, your memory power in a few short hours, that they are willing to send the course on free examinations.

Don't send any money. Merely mail the coupon or write a letter and the complete course will be sent, all charges prepaid, at once. If you are not entirely satisfied send it back any time within five days after you receive it and you will owe nothing.

On the other hand, if you are as pleased as are the thousands of other men and women who have used the course, send only \$5 in full payment. You take no risk and you have everything to gain, so mail the coupon now before this remarkable offer is withdrawn.

FREE EXAMINATION COUPON

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Publishers of the Independent Weekly

Dept. R-773, 119 West 40th Street, New York

Please send me the Roth Memory Course of seven lessons. I will either remail the course to you within five days after its receipt or send you \$5 in full payment of the course.

Name

Address

.....Pop. Science Mo.—3-20



"Of Course I Place You! Mr. Addison Sims of Seattle"

hundred words so that I could call them off forward and back without a single mistake.

That first lesson stuck. And so did the other six.

Read this letter from Terence J. McManus, of the firm of Olcott, Bonyng, McManus & Ernst, Attorneys and Counselors at Law, 170 Broadway, and one of the most famous trial lawyers in New York:

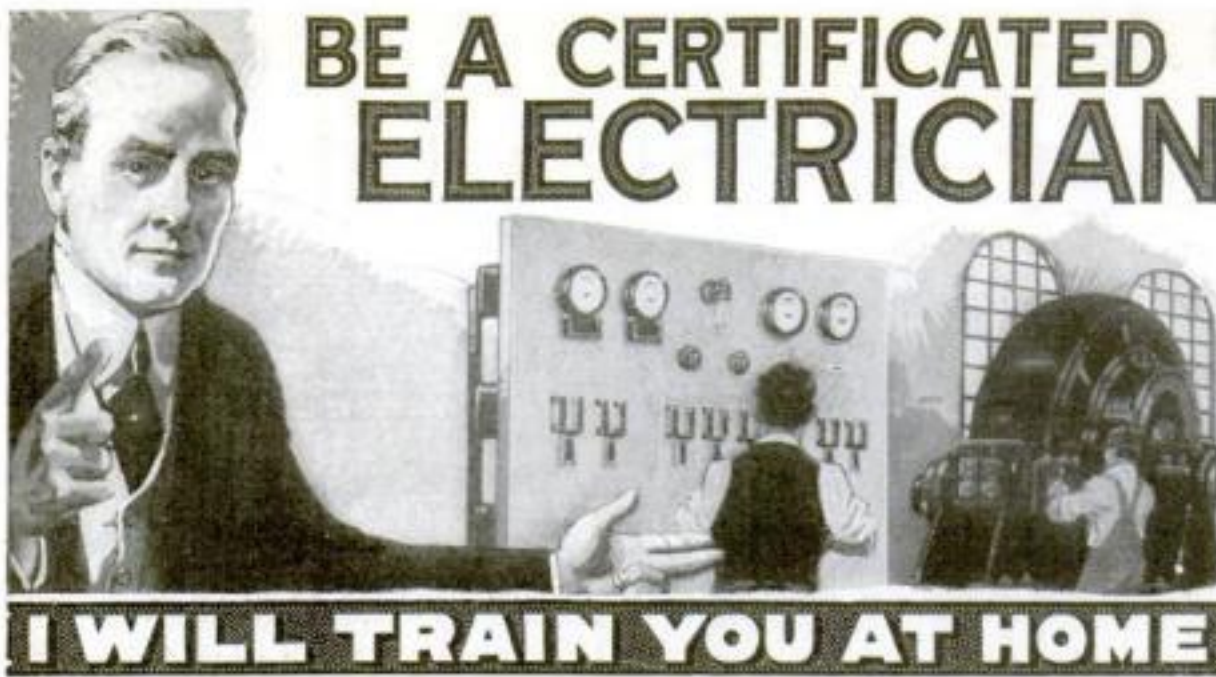
"May I take occasion to state that I regard your service in giving this system to the world as a public benefaction. The wonderful simplicity of the method, and the ease with which its principles can be acquired, especially appeal to me. I may add that I already had occasion to test the effectiveness of the first two lessons—the preparation for trial of an important action in which I am about to engage."

Mr. McManus didn't put it a bit too strong. The Roth course is priceless! I can absolutely count on my memory now. I can call the name of most any man I have met before—and I am getting better all the time. I can remember any figures I wish to remember. Telephone numbers come to mind instantly, once I have filed them by Mr. Roth's easy method. Street addresses are just as easy.

The old fear of forgetting (you know what that is) has vanished. I used to be "scared stiff" on my feet—because I wasn't sure. I couldn't remember what I wanted to say.

Now I am sure of myself, and confident, and "easy as an old shoe" when I get on my feet at the club, or at a banquet, or in a business meeting, or in any social gathering.

Perhaps the most enjoyable part of it all is that I have become a good conversationalist—and I used to be silent as a sphinx when I got into a crowd of people who knew things.



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I WILL TRAIN YOU AT HOME

Prepare NOW, and be ready in a few months to earn your

\$60 to \$150 A WEEK

The country needs thousands of trained, Certified Electricians to fill good positions—and at big pay. It's all a matter of knowing how, and I will teach you by up-to-date, modern instruction. You can learn at home, without interfering with your regular work, by my highly successful method of **Home Instruction in Practical Electricity**.

A Real Position Like This—for YOU

Send for this Book—

My book, "**HOW TO BECOME AN EXPERT ELECTRICIAN**," has started thousands of young men on the way to splendid success. A new edition of this has just been printed. I want every young man interested in Electricity to have a copy, and send you one, **ABSOLUTELY FREE AND PREPAID**. Write me today.

How I Train My Students

As Chief Engineer of the Chicago Engineering Works I know exactly the kind of training a man needs to enable him to get and hold good positions, and to earn big pay. I have trained hundreds of men who are holding splendid electrical jobs.

I give each of my students personal attention and a complete and thorough training. I give him a **SPLENDID ELECTRICAL OUTFIT FREE**, and much of the training is done by actual work. When my students graduate and receive their certificate they are ready for a real position. But **still more**, at any time you wish you can come to our splendidly equipped Electrical Shops for special training. No other school can give you this.

A Real Opportunity for YOU

Wishing is never going to make your dreams come true. You've got to **study—to learn**. A man is worth only \$2 or \$3 a day from his neck down—and no more; but there is **no limit** to what he can be worth from his neck up.

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I am continually receiving requests from employers to send them trained Electrical men. I assist my students to secure good positions. I keep in touch with them for years, helping and advising them in every possible way.

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Delay never got you anything. Action is what counts. Get started—and get started now. Write me, or send me the coupon, right NOW.

L. L. COOKE, Chief Engineer

CHICAGO ENGINEERING WORKS

DEPT. 33

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Eng.
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complete particulars of your
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YOU CAN DO IT

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New Oliver Typewriters At About Half Price

**Latest Model
Number Nine**

**Was \$100
Now \$57**

**FREE TRIAL—
No Money Down
Over a Year to Pay**



Save \$43

By This New Plan—Be Your Own Salesman

**The Guarantee of a \$2,000,000 Concern
That This \$57 Typewriter Was \$100**

During the war we learned that it was unnecessary to have great numbers of travelling salesmen and numerous, expensive branch houses throughout the country. We were also able to discontinue many other superfluous, costly sales methods. You benefit by these savings. The \$57 Oliver is the identical machine that was formerly \$100. Not one change has been made in design or materials. Each machine is a new Oliver—our latest and finest product.

The \$100 Model

The Oliver Nine is the finest, the costliest, the most successful model we ever built. If any typewriter is worth \$100, it is this handsome machine, the greatest Oliver triumph.

Over 800,000 have been sold. This is the same commercial machine used by the U. S. Steel Corporation, the Standard Oil Company, the National City Bank of New York, Montgomery Ward & Co., the Pennsylvania Railroad, and a host of others. Any operator can use the Oliver.

Free Trial; No Money Down

Here is our plan: We ship an Oliver Nine to you for five days free trial. No money down—no C.O.D. Use it in your office or at home. Try it—without anyone to influence you.

If you want to keep it, send us \$3 per month.

If you want to send it back, we even refund the out-going transportation charges.

That is the entire plan. You are the sole judge. At no time during the trial are you under the slightest obligation to buy. Superiority and economy alone must convince you.

Amazing Facts

We have just published a startling book, entitled "The High Cost of Typewriters—The Reason and

the Remedy," which reveals the inside history of the typewriter world—old customs of selling—secrets never before divulged—all about price inflation—subsidies, etc. All the follies of \$100 pricing are exposed. Readers are astounded.

Mail the coupon now. You will be surprised.

This book tells everything. With it we send our catalogue, free trial order blanks, etc. After reading it, you may order a free-trial Oliver.

Canadian Price, \$72

The Oliver Typewriter Company 97.02
1103 Oliver Typewriter Bldg., Chicago, Ill.

**FREE
BOOK**

THE OLIVER TYPEWRITER CO.,
1103 Oliver Typewriter Bldg., Chicago, Ill.

☐ Ship me a new Oliver Nine for five days free inspection. If I keep it, I will pay \$57 at the rate of \$3 per month. The title to remain in you until fully paid for.

My shipping point is.....
This does not place me under any obligation to buy. If I choose to return the Oliver, I will ship it back at your expense at the end of five days.

☐ Do not send a machine until I order it. Mail me your book—"The High Cost of Typewriters—The Reason and the Remedy," your de luxe catalog and further information.

Name

Street Address

City.....State.....

Occupation or Business.....

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Raise Your Income

Get into this paying profession and have positions opened to you by manufacturers, architects, railroads, contractors—by every kind of a corporation where mechanical design and construction are carried out. Draftsmanship puts you in the class of specialists, raises you above the crowd of job hunters, makes you a man whose services are needed.

You have the same opportunity to get the training that other men had who took the Chicago "Tech" Course in Draftsmanship and are now drawing large salaries and holding important, responsible positions. You also can learn how to earn

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a cash credit in case he already has an outfit. You use them while learning—then take them right into your practical work.

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Every student of the Chicago "Tech" Home Study Course in Draftsmanship receives this drawing outfit—set of instruments in case, drawing board, T square, triangles, scale, curve, drawing paper, pencils, etc., or



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Low tuition fees and easy terms of payment. Pay as you go along. Get training which will soon repay in extra earnings all the cost of course. You know the salaries received by skilled technical men. Get information on the opportunities which are opened wide to you by Chicago "Tech."

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Mark X opposite work in which you are especially interested.

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| <input type="checkbox"/> Electrical Drafting | <input type="checkbox"/> Estimating |
| <input type="checkbox"/> Structural Drafting | <input type="checkbox"/> Surveying |
| <input type="checkbox"/> Sheet Metal Drafting | <input type="checkbox"/> Autos and Gas Engine |
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All about automobile mechanism—its construction, operation and REPAIRS—taught by mail. You train directly under the Chicago "Tech" automobile experts. Learn all about Principles of the Automobile, all about Gas Engines, Power Plants, Transmissions, Lubrication, Cooling, Batteries, Starting and Lighting Systems, etc.

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Most complete instruction in auto repair work. Equips you for high pay or to start a business. Big demand for trained repair men.

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Complete, practical instruction in Aeronautic Engineering. Every principle made clear. Construction of every type of machine fully explained. This course equips you for expert work. Get the catalog and information. Send coupon.

Shave a New Way

—Easier, Quicker, Pleasanter
Then Compare It With the Old Way

Facts such as these convince the home shaver that harsh, slow ways are no longer necessary. Shavaid, the new, soothing beard-softener, replaces annoying and harmful operations, saves time, gives new delight. To learn its merit, send for a Free Trial Tube.

HERE is a new satisfying way to gain a comfort shave. A way now being adopted by men the nation over.

This welcome offering is Shavaid. It is a scientific preparation, perfected after countless experiments and tests.

It revolutionizes home shaving. It turns an irksome task into a refreshing pleasure. Once you try it you will never give it up.

It Saves All This

Shavaid saves hot water applications. It saves rubbing the lather in. It saves waiting for the beard to soften. It saves doctoring an irritated skin with lotion afterwards. It means a quick shave, an easy shave, a luxury shave. It avoids discomforts in a close shave. It does instantly what old shaving methods never could do at all.

If all this is so, you want it. You will never shave without it. No man abuses his face willingly.

Old vs. New

Simply coat the dry beard thinly with Shavaid, before applying lather. Note the cooling, soothing effect.

Note how the lather remains moist and creamy.

Shavaid

Softens the beard instantly

—apply to dry face before the lather.

Saves time and trouble

—no hot water, no "rubbing in" of the lather.

Protects the face

—skin remains firm and smooth.

Removes the razor "pull"

—harsh ways age the skin prematurely.

Replaces after-lotions

—Shavaid is a cooling, soothing balm.

This way is quicker. Yet it protects the skin. Harsh treatments bring wrinkles too soon.

Hot water applications make the face tender and bring the blood to the surface. That causes abrasions.

With Shavaid, you can obtain a close shave without irritation. The Shavaid way keeps the skin firm and smooth.

The razor glides over easily. And best of all, no lotions are necessary afterwards, for Shavaid is in itself a cooling, soothing, healing emollient. Its daily use keeps the cuticle in condition.

See If You Agree

We realize in introducing such an innovation that the quickest way for it to win its rightful popularity, is to

hasten its use by as many men as possible.

So we offer here, via coupon, a Free Trial Tube. It contains sufficient Shavaid for a convincing test.

After using this Trial Tube, and agreeing that you do not want to be without it, you can then buy Shavaid from your druggist at 50c. a tube.

If your dealer cannot supply Shavaid we will be pleased to furnish it direct.

B&B
Shavaid

At Druggists—50c. a Tube

BAUER & BLACK, Chicago, New York, Toronto

Makers of Sterile Surgical Dressings and Allied Products



BAUER & BLACK, Chicago, Ill.

Mail free tube of Shavaid to

Name.....

Street Address.....

City..... State.....



Free Proof That I Can Raise Your Pay

No matter how much you are earning now, I can show you how to increase it. I have even taken failures and shown them how to make \$100—\$200, and in one case as high as \$2,000 weekly. I am willing to prove this entirely at my risk and expense.

LET'S have a little chat about getting ahead—you and I. My name is Pelton. Lots of people call me "The Man Who Makes Men Rich." I don't deny it. I've done it for thousands of people—lifted them up from poverty to riches.

I'm no genius—far from it. I'm just a plain, everyday, unassuming sort of man. I know what poverty is. I've looked black despair in the eye—had failure stalk me around and hoodoo everything I did. I've known the bitterest kind of want.

But to-day all is different. I have money and all the things that money

will buy. I am rich also in the things that money won't buy—health, happiness and friendship. Few people have more of the blessings of the world than I.

IT was a simple thing that jumped me up from poverty to riches. As I've said, I'm no genius. But I had the good fortune to know a genius. One day this man told me a "secret." It had to do with getting ahead and growing rich. He had used it himself with remarkable results. He said that every wealthy man knew this "secret,"—that is why he was rich.

I used the "secret." It surely had a good test. At that time I was flat broke. Worse than that, for I was several thousand dollars in the hole. I had about given up hope when I put the "secret" to work.

At first I couldn't believe my sudden change in fortune. Money actually flowed in on me. I was thrilled with a new sense of power. Things I couldn't do before became as easy for me to do as opening a door. My business boomed and continued to leap ahead at a rate that startled me. Prosperity became my partner. Since that day I've never known what it is

to want for money, friendship, happiness, health or any of the good things of life.

That "secret" surely made me rich in every sense of the word.

MY sudden rise to riches naturally surprised others. One by one people came to me and asked me how I did it. I told them. And it worked for them as well as it did for me.

Some of the things this "secret" has done for people are astounding. I would hardly believe them if I hadn't seen them with my own eyes. Adding ten, twenty, thirty or forty dollars a week to a man's income is a mere nothing. That's merely playing at it. In one case I took a rank failure and in a few weeks had him earning as high as \$2,000.00 a week. Listen to this:

A young man in the East had an article for which there was a nationwide demand. For twelve years he "puttered round" with it, barely eking out a living. Today this young man is worth \$200,000. He is building a \$25,000 home—and paying cash for it. He has three automobiles. His children go to private schools. He goes hunting, fishing, traveling whenever the mood strikes him. His income is over a thousand dollars a week.

In a little town in New York lives a man who two years ago was pitied by all who knew him. From the time he was 14 he had worked and slaved—and at sixty he was looked upon as a failure. Without work—in debt to his charitable friends, with an invalid son to support, the outlook was pitchy black.

Then he learned the "secret." In two weeks he was in business for himself. In three months his plant was working night and day to fill orders. During 1916 the profits were \$20,000. During 1917 the profits ran close to \$40,000. And this genial 64-year-old man in enjoying the pleasures and comforts he little dreamed would ever be his.

I COULD tell you thousands of similar instances. But there's no need to do this, as I'm willing to tell you the "secret" itself. Then you can put it to work and see what it will do for you.

I don't claim I can make you rich over night. Maybe I can—maybe I can't. Sometimes I have failures—everyone has. But I do claim that I can help 90 out of every 100 people if they will let me.

The only point of it all, my friend, is that you are using only about one-tenth of that wonderful brain of yours. That's why you haven't won greater success. Throw the unused nine-tenths

of your brain into action and you'll be amazed at the almost instantaneous results.

The Will is the motive power of the brain. Without a highly trained, inflexible will, a man has about as much chance of attaining success in life as a railway engine has of crossing the continent without steam. The biggest ideas have no value without will-power to "put them over." Yet the will, although heretofore entirely neg-

Develop your will-power and money will flow in on you. Rich opportunities will open up for you. Driving energy you never dreamed you had will manifest itself. You will thrill with a new power—a power that nothing can resist. You'll have an influence over people that you never thought possible. Success—in whatever form you want it—will come as easy as failure came before. And those are only a few of the things the "secret" will do for you. The "secret" is fully explained in the wonderful book "Power of Will."

How You Can Prove This at My Expense

I KNOW you'll think that I've claimed a lot. Perhaps you think there must be a catch somewhere. But here is my offer. You can easily make thousands—you can't lose a penny.

Send no money—no, not a cent. Merely clip the coupon and mail it to me. By return mail you'll receive not a pamphlet, but the whole "secret" told in this wonderful book, "POWER OF WILL."

Keep it five days. Look it over in your home. Apply some of its simple teachings. If it doesn't show you how you can increase your income many times over—just as it has for thousands of others—mail the book back. You will be out nothing.

But if you do not feel that "POWER OF WILL" will do for you what it has done for over a quarter of a million others—if you feel as they do that it's the next greatest book to the Bible—send me only \$3.50 and you and I'll be square.

If you pass this offer by, I'll be out only the small profit on a three-and-a-half dollar sale. But you—you may easily be out the difference between what you're making now and an income several times as great. So you see you've a lot—a whole lot—more to lose than I.

Mail the coupon or write a letter now—you may never read this offer again.

PELTON PUBLISHING CO.

14F Wilcox Block, Meriden, Conn.



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PORTABLE Garages, wood or steel, reasonable prices. Bona Fide Building Mfrs., 22 Borden Avenue, Long Island City.

HYDRONIZER: Insures clean plugs, consumes carbon, saves gasoline, intensifies power and increases speed. For all cars. Money back guarantee. Big profits for agents. Free literature. Priestly Manufacturing Company, 2933 West Lake Street, Chicago.

MORE Power, less fuel, no carbon. No mystery, plain facts, results guaranteed. Write for booklet. No-Leak-O Piston Ring Company, Baltimore, Maryland.

PATENTS—Write for Free Illustrated Guide Book and Evidence of Conception Blank. Send model or sketch and description of invention for our opinion of its patentable nature. Highest references. Reasonable terms. Victor J. Evans & Company, 189 Ninth, Washington, D. C.

AUTO Motor Supplies. Buick, Michigan, Stoddard Dayton, Hupp 32, Cadillac, Overland, E. M. F., Continental and Buick Motors, all types, \$50 each and up. Bosch Magneto, \$15 each and up. Special high tension 2 and 4 cylinder magnetos, \$9.50 each. Prest-O-Lite tanks, \$5.00. Cells, carburetors, air compressors, generators, starters, etc. Write for Bargain Bulletin. Second hand auto accessories. Address Motor Sales, Dept. 14, West End, Pittsburgh, Pennsylvania.

ENORMOUS demand: Sell Tankli; Modern auto-fuel, 100 to 200% profit.—"Vapor-Spray" system burns water. Adds tremendous power. Tankli, Cleveland, Ohio.

INSYDE Tyres, inner armor for automobile tires, double mileage and prevents punctures and blowouts. Quickly applied. Cost little. Demand tremendous. Profits unlimited. Details free. American Automobile Accessories Co., Dept. F3, Cincinnati, Ohio.

AUTOMOBILE Parts for all cars—50% off manufacturers' list price. Pistons, connecting rods, cam shafts, crank shafts, cylinders, axles and gears. Our new catalogue and Used Parts Bulletin now ready. Write for it to-day. Service and satisfaction guaranteed. Auto Parts Company, 4108 Olive Street, St. Louis, Missouri.

TIRES. Factory-to-You Prices. Exclusive representative wanted each locality to use and sell Mellinger Extra Ply Tires. Guarantee Bond 8000 Miles. Sample sections furnished. Mellinger Tire Company, 937 Oak Street, Kansas City, Missouri.

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TIRES at Wholesale. Send for prices on 7,500 mile guaranteed tires and tubes. We have the cheapest high-grade, long life and reliable tires in the world. No "seconds" or rebuilt tires. Overton Rubber Company, Oelwein, Iowa.

INSYDE Tyres, inner armor for Automobile Tires, prevents punctures and double mileage of any tires. Liberal profits. Details free. American Accessories Co., Dept. 97-A, Cincinnati, Ohio.

BATTERY Charging pays big profits. City currents or gas engine operates. Easy terms. Hobart, Troy, Ohio.

RED DEVIL Auto Polish—Brightens the way. Regular 60c. can, 50c. to introduce. Agents wanted. Red Devil Products, Dept. 1, Farmingdale, New York.

SAVE money! Make money! Work for yourself or for others. Know about auto construction and repairs. Illustrated catalog and new instructive books sent free. Dept. B-6, Automobile Digest, Cincinnati, Ohio.

FORD ACCESSORIES

FORDS start easy in cold weather. Will run 34 miles per gallon on cheapest gasoline or half kerosene using our 1920 carburetors. Increased power styles for all motors, can attach them yourself. Big profits to agents: money back guarantee; 30 days' trial; Air Friction Carburetor Company, 500 Madison Street, Dayton, Ohio.

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MOTOR Tire Pump for Fords. Can be made by any Ford owner from discarded parts. Serviceable and efficient. A handy labor and time saver. Full instructions and drawings mailed, \$1.50 (no stamps). Stoeckle Company, Box A117, Baltimore, New York.

PISTON Rings, Timers, Valve Lifters, Adjustable Valves, etc., just what you will require when overhauling your Ford. Write for our money saving circular at once. S. & C. Company, P. O. Box 678, Meriden, Connecticut.

ARE you interested in Automobile construction, repairing, etc? Send for FREE Illustrated catalogue of new instructive books. Department B-2, Automobile Digest, Cincinnati, O.

FORDS double the mileage with Heard Carburetors. Easiest starting carburetor made. Double the power. Satisfaction guaranteed. Free trial. Agents wanted. York Sales Company, Dept. PS, 1518 East Jefferson Avenue, Detroit, Michigan.

TIMER Brush. New wiping contact; quick starting; easiest running. Only 34 cents, prepaid. R. Sp. Works, Box 543, Riverside, California.

MR. ADVERTISER: Ask to-day for a copy of the "Quick-Action Advertising Rate Folder." It contains some really important facts which will prove interesting and valuable to you. It also tells "How You Can Use Popular Science Monthly Profitably." You'd like to know, wouldn't you? Manager Classified Advertising, Popular Science Monthly, 225 West 39th Street, New York.

ELECTRICAL

BLUEPRINTS—Electrical connections. 230 A. C. motor, single, two and three phase. Voltage, cycle, phase changing. 123 D. C. Voltage changing, etc. 120 transformer connections. 150 rheostats, controllers, compensators, internal and external. 10 samples A. C., 25c. Particulars free. Charles Chittenden, Dept. 8, 3024 Matthews Avenue, Kansas City, Missouri.

ELECTRICIANS, Wiremen, Linemen, send your name and address for descriptive literature of our Modern Blue Print Chart Method of Electrical Wiring. Over 350 practical diagrams. Electrical Wiring Diagram Company, Box B173, Altoona, Pennsylvania.

SELENIUM CELLS—We are manufacturers of high class Selenium Cells, highly sensitive and quick acting; also relays to be used in conjunction therewith. Suitable for all experiments, from \$2 up. Write for Catalogue. Selenium Laboratories, Good Ground, New York.

ILLUSTRATED catalog just issued. Generators, motors, sockets, wire switches, porcelain material. Hyre Electric Company, 629 PD South Dearborn Street, Chicago.

MAKE Dry Batteries. Simple, practical instructions, with blue print, 25 cents. Dirigo Sales Company, Bath, Maine.

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Now and then we receive the kind of letter that no publisher likes to get—a cancellation. For when a magazine has built up a worthwhile section of high-class advertisers, it regrets to see any one withdraw for any reason. But when the CAUSE is explained as follows, there's a natural sense of gratification felt by all concerned:

"Our advertisement has given such splendid results that, owing to our stock being depleted through orders received from Popular Science Monthly, it will be necessary to cancel our notice until you hear from us further."

CHARLES E. TUCKER & SON.

"The business received from Popular Science Monthly greatly exceeded our expectations and the stock that we had in hand was quickly exhausted."

DIRIGO SALES COMPANY.

"It certainly was not because of insufficient orders that we cancelled our advertisement, but because we received so many replies that we were unable to give them proper attention."

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It will only cost YOU 25 Cents a Word to talk to this vast audience of BUYERS. Why don't you?

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225 West 39th Street
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EARN \$40 to \$100 weekly. Learn paperhanging, decorating, sign, scenic and auto painting, showcard writing, graining. Catalogue free. Chicago Painting Schools, 133 North Wells Street, Chicago.

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WIRELESS

EXPERIMENTAL. Wireless Stations—Bargain Price. For boys just beginning radio this is an excellent book. The spark systems and crystal-receiver apparatus described are adequate for anyone who wishes to start out in the radio field. Complete instructions for sending and receiving apparatus are included. To dispose of a few remaining copies of the old edition, the price is 75c. The new edition is \$2.00. Book Department, Popular Science Monthly, 225 West 39th Street, New York City.

SIMPLE Wireless Telephones and How to Make Them. A good book for the advanced radio amateur on the principles, construction and use of the wireless telephone. Price 25 cents postpaid. Book Dept., Popular Science Monthly, 225 West 39th Street, New York.

MOTORCYCLES, BICYCLES, SUPPLIES

MOTORCYCLES all makes, \$25.00 up. New bicycles at big reduction. Second hand, \$8.00 up. Motors, motor attachments, Cycle motors, Smith motor wheels, etc., \$20.00 up. New parts to fit all makes carried in stock. Second hand parts good as new 50% discount. Expert repairing, on magnetos, generators, transmissions. Motors overhauled \$10.00 up. Henderson motors our specialty. Write for big bargain bulletin. American Motor Cycle Company, Dept. 3, Chicago.

REBUILT motorcycles at half cost of new machines. Write for Bargain Bulletin. Western Supplies Company, 371 Hayutin Building, Denver, Colorado.

\$25.00 Up—Guaranteed rebuilt motorcycles—Henderson, Excelsior, Indian, Harley-Davidson. Bicycles, \$5.00 up. Tires and accessories at wholesale. Illustrated bulletin "A" free. Ash Motor Corporation, 162 North Clinton Avenue, Rochester, New York.

MOTORCYCLES—Buy now while prices are low. Large stock on hand. Harleys, Indians, Excelsior, Henderson, Pops, Reading-Standards and others. Tires and tubes at big reductions; state size wanted. Machines all overhauled and guaranteed running condition. Illustrated catalogue "F." Carl W. Bush Company, Newark, New Jersey.

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WE do Metal Stamping, Die and Model Work, Gold, Silver, Nickel, Copper and Brass Plating; also special finishes. We will manufacture your article either on straight time or contract basis. When our tool or model maker is on your job, you are welcome at his bench. Denning Manufacturing Company, 1775-1777 East 87th Street, Cleveland, Ohio.

TO Order: Any article in metal; models, tools, patterns, experimenting, manufacturing. Inventions developed. Cleveland Specialty and Manufacturing Company, Cleveland, Ohio.

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THE American School of Aviation announces a new correspondence course in Mechanics of Aviation. A thorough training in practical aeronautics. American School of Aviation, Dept. 1863, 461 South Dearborn Street, Chicago.

AIRPLANES—1 to 6 passenger; aeronautical motors 30 to 300 H.P. Lowest prices. State your needs. Send for lists "P. S." Aero Exchange, 38 Park Row, New York.

THAT unassembled Ford or motorcycle airplane now ready, complete literature of either. 2c stamp. Latest motor or propeller catalogue. 4c each. Thousands of Government test standard turnbuckles at ½ less than factory cost. Heath Airplane Company, Chicago.

INVENTORS desiring information write for our Free Illustrated Guide Book and Evidence of Conception Blank. Send model or sketch of invention for our opinion of its patentable nature. Highest references. Prompt service. Reasonable terms. Victor J. Evans & Company, 151 Ninth, Washington, D. C.

THE Aerocar—Aviation type speedster, developed along aerodynamic lines and driven by an aeroplane propeller. As easily operated as a bicycle and capable of high speed. Parts inexpensive. Send 50c for construction plans. Aerocar Company, Racine, Wisconsin.

WELDING AND SOLDERING

DON'T scrap aluminum parts! Save them, with 8o-Luminum. New, great "3-in-1" welding, brazing and soldering compound, stronger than aluminum—perfect substitute for acetylene welding—½ time and cost. Use gasoline torch or soldering iron. No flux. Booklet 9. Sample bar \$1.00. Used by United States Army and Navy, endorsed by British Munitions Board. 8o-Luminum Manufacturing Company, 1790 Broadway, New York.

WELDING PLANTS, \$25.00 to \$300.00. Designed for all purposes. Small cash payment, balance three to six months. Every mechanic or shop should have one. Bermo Welding Co., Omaha, U. S. A.

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WE pay the highest prices for diamonds, platinum, watches, old or broken jewelry, old gold, silver, magneto points, old false teeth, gold or silver ores or nuggets, War Bonds and Stamps. Mail them to us today. Cash by return mail. Goods returned in 10 days if you're not satisfied. The Ohio Smelting and Refining Company, 238 Lennox Building, Cleveland, Ohio.

WANTED—Representatives in every Factory in the United States. Popular Science Monthly, 225 West 39th Street, New York.

CASH for Old False Teeth. We pay up to \$35.00 per set (broken or not). Also buy discarded gold jewelry, gold crowns, bridges, platinum, diamonds, watches and silver. Send now. Cash by return mail. Package held 5 to 10 days for senders' approval of our offer. U. S. Smelting Works, Dept. 81, Chicago, Illinois.

WANTED—Small gasoline and steam engines. Drill presses, lathes, electric motors, etc. Will pay high cash prices for good material. Johnston, West End, Pittsburgh, Pennsylvania.

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DUPLICATE keys for all Yale and similar locks made in one minute with Harrison Key Filing Machine. No misfits. Thousands in use. Sent prepaid \$5.00. Money returned if not satisfactory. Harrison & Company, 83 New Street, New York.

DUPLICATING DEVICES

"MODERN" Duplexator—a Business Getter, \$1.50 up. 50 to 75 copies from pen, pencil, typewriter; no glue or gelatine. 35,000 firms use it. 30 days' trial. You need one. Booklet Free. J. V. Durkin & Reeves Company, Pittsburgh, Pennsylvania.

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SHORTHAND Made Easy by "the greatest living authority on shorthand," Oliver McEwan, author of McEwan's easy shorthand, declared by experts to be "the simplest, the briefest and most legible ever devised." Now being studied by over 500 superintendents of schools, high school and business school principals. 1000 teachers wanted. Practically free training. McEwan Shorthand Corporation, 72 West Adams Street, Chicago.

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TYPEHAND shorthand. Wonderful new shorthand system. Learn in 10 minutes. Simple, easy, sure. Price \$1.00. Particulars free. Winslow P. Chase, Washington, D. C.

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"SEXUAL Philosophy." 12c. Clear, specific, authoritative, complete, best satisfies. Fred B. Kaessmann, Lawrence, Mass.

GET Ahead! Gain in individuality and power! Success studygram, and personality sketch for 10c and birthdate. Thomson-Heywood Company, 89 Chronicle Building, San Francisco.

CIGARETTE Smokers, attention! Newest patent pocket cigarette roller, rolls any tobacco. Sent on receipt of 40 cents coin. Perfection Cigarette Roller Company, Box 35, Station J, Brooklyn, New York.

MAKE \$19.00 Hundred Stamping Names on Key checks. Send 25c for sample and instructions. PS Keytag Company, Cohasset, New York.

STOP falling hair! Stop itching scalp! Send \$1.00 and I will tell you something to apply to your scalp, twice a week, that will dissolve and quickly eradicate every particle of dandruff and stop falling hair. No tonic. Pure and simple. Wm. Foster, Expert on Scalp Treatment, 3901 Grand Boulevard, Chicago, Illinois.

OIL-PROOF Caps—"Can be washed in oil." Made from tan or black leatherette in latest style. Non-breakable peaks. \$2.00. Zuckerman, 204 West 23rd Street, New York, New York.

PYORRHEA—Fleeting or swollen gums: "Pyorem." A successful home treatment. Purifying, healing, preventative. Full month's treatment, \$1.00; or write for free booklet. Pyorem Mfg. Company, 439 Seventh Street, Brooklyn, New York.

BE a detective. Excellent opportunity, good pay, travel. Write C. T. Ludwig, 424 Westover Bldg., Kansas City, Mo.

GET vital strength! Retain youthful vigor. Wonderful results. Intensely interesting booklet free. Winslow E. Chase, Washington, D. C.

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DETECTIVES—Great demand, excellent opportunity. Experience unnecessary. Write American Detective System, 1968 Broadway, New York.

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BIBLE Against Prohibition. Proved. Argument settler. Every quotation. 20c; description, 3c. Torch Publishing Company, Maryland Bank Building, Baltimore, Maryland.

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PLAYS, vaudeville acts, monologs, dialogs, recitations, pageants, musical readings, special entertainments, tableaux, drills, minstrel jokes, make-up goods. Large Catalog Free. T. S. Denison & Company, Dept. 26, Chicago.

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TRICKS and Greenbacks. Big magic catalog 5c. Twenty greenbacks—10c. Gilmaccio, 11135 South Irving, Chicago.

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AGENTS—My Wholesale Joke Catalogue Free. Mears, 66, Anderson, Indiana.

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IS this your idea of Florida? A little piece of land near the water, a boat, a garden, some strawberry plants, and perhaps a few chickens; a vine-covered cottage among your own orange and grapefruit trees; fish and oysters in abundance; plenty of quail and game—a simple, natural, wholesome life in the open the year round—home, health, and contentment. All this is within your reach at modest outlay in this beautiful land of sunshine and roses. We are on the Gulf and a navigable river; also on the Dixie Highway. Here we have the freedom, comfort and economy of country life, yet are only two hours by motor bus from big cities and resort centers like Tampa and St. Petersburg, and we are only eight miles from Tarpon Springs. Our community is new and prices have not gone sky-high; living expenses are moderate. Over 100 Northern families already here. They like it—perhaps you will. May we send complete information? Board of Trade, Box 603, New Port Richey, Florida.

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AL PIANTADOSI Company, Music Publishers, 232 West 46th Street, New York City, for popularizing purposes, offer their latest waltz song, "Egyptian Nights," 30c seller, and eleven other choice song hits, postpaid, for \$1.00.

WRITE the words for a song. We write music, guarantee publisher's acceptance. Submit poems on patriotism, love or any subject. Chester Music Company, 920 South Michigan Avenue, Room 111, Chicago.

WRITE the words for a song. We revise poems, write music and guarantee to secure publication. Submit poems on any subject. Broadway Studios, 121C Fitzgerald Building, New York.

WRITE a Song—Love, mother, home, childhood, patriotic or any subject. I compose music and guarantee publication. Send words to-day. Thomas Merfin, 238 Reaper Block, Chicago.

YOU write words for a song—we write the music, publish, and secure a copyright. Submit poems on any subject. The Metropolitan Studios, 914 South Michigan Avenue, Room 106, Chicago, Illinois.

SONG-WRITERS' Manual and Guide Sent Free! Contains valuable instructions and advice. Submit song-poems for examination. We will furnish music, copyright and facilitate publication or sale. Knickerbocker Studios, 315 Galety Building, New York.

HAVE you song poems? I have best proposition. Ray Hibbele, D-1, 4040 Dickens Avenue, Chicago.

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CORNETISTS—Trombonists: "Free Pointers" on weak lip—high tones. Virtuosos Cornet School, Buffalo, New York.

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BUILD your own phonograph. Big saving. Pleasant, instructive work. Complete instructions, blue-prints, etc., absolutely free. Write to-day. Associated Phonograph Company, Dept. F1, Cincinnati, Ohio.

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TEN Wonderful Snapshots with explanatory booklet of my experiences in the South Sea Islands, Philippines and China Sea. They are gems for any album. Price, \$1.00 Money refunded if not delighted. J. C. Jeffries, 710 East Saturn Street, Huntington Park, California.

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900 Mechanical Movements, also illustrations explaining 50 Perpetual Motions. My book, Inventor's Universal Educator, Fifth Edition, tells how to procure and sell patents. Government and other costs. Covers the matter from A to Z. 160 pages elegantly bound. Contains noted decisions of U. S. Supreme and State Courts on Patent Cases. Mechanical Movements greatly assist inventors—suggest new ideas that may prove of great aid in perfecting inventions. Tells how to select an Attorney. Has valuable information regarding Patent Sharks. Selling Agents and Brokers Price \$2. Postage Free everywhere. Fred G. Dieterich, 681 Ouray Building, Washington, D. C.

PATENTS—Write for free Guide Book and Evidence of Conception Blank. Send model or sketch of invention for free opinion of its patentable nature. Highest references. Reasonable terms. Victor J. Evans & Company, 156 Ninth, Washington, D. C.

HAVE you a practical invention to sell outright or place on royalty? Send details to Adam Fisher Mfg. Co., 183 A, St. Louis, Missouri.

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INVENTOR'S Adviser Free; gives valuable information and advice. Write F. Ledermann, 15 Park Row, New York.

INVENTORS: We make models, dies, tools. 25 years' experience; work guaranteed; lowest price. Manufacture of specialties our hobby. Peerless Die & Tool Company, 121 Opera Place, Cincinnati, Ohio.

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NEVER Sell Old Coins until you see our Copyrighted 6x9 Illustrated Coin Value Book (New Edition)—showing high prices we pay. \$100.00 paid for 1894 dime, 8 Mint. Send 10c for your copy to-day. You may have valuable coins. International Coin Co., Box 151-M, Philadelphia, Pennsylvania.

CALIFORNIA gold, quarter size, 27c; 3/4 size, 53c. White cent and catalogue 10c. Norman Schultz, King City, Missouri.

100 Different Stamps, 10c; 200, 25c. Approvals. Michaels, 5600 Prairie, Chicago.

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158 Genuine Foreign Stamps—Mexico War Issues Venezuela, Salvador and India Service. Guatemala, China, etc., only 10c. Finest Approval Sheets 50% to 60%. Agents wanted. Big 72-p. Lists Free. We buy stamps. Established 25 years. Hussman Stamp Company, Dept. 55, St. Louis, Missouri.

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STAMPS, 61 All Different, 3 cents. Mention paper. Quaker Stamp Co., Toledo, Ohio.

\$2 to \$600 paid for hundreds of old coins dated before 1895. Send 10 cents at once for new illustrated coin value book. Size 4x7. It may mean your fortune. Clarke & Co., Coin Dealers, Box 76, LeRoy, N. Y.

PACKET "A" 100 varieties foreign stamps, 20c. F. J. Pope, Charlotte, Vermont.

17 Varieties Hayti Stamps 20c. List of 7000 varieties low priced stamps free. Chambers Stamp Co., 111C, Nassau Street, New York City.

STAMPS—50 varieties, Transvaal, Brazil, Peru, Cuba, Mexico, etc., and Album 10c. 50 different U. S., 25c, 1,000 hinges, 10c, 1,000 mixed 40c. List free. I buy stamps. C. Stegman, 5949 Cote Brillante, St. Louis, Missouri.

CALIFORNIA gold, quarter size and Columbia Nickel, 30c. Villa coin and catalog, 10c. Homer Schultz, Union Star, Missouri.

STAMPS—50 different British Guiana, China, Japan, Portugal, Venezuela, etc., 10c; 1,000 all different, fine collection in itself, \$5.00; 100 various U. S. 50c; 1,000 hinges, 10c; agents wanted, 50 per cent. List free. I buy stamps. L. B. Dover, Overland, Missouri.

BEST one cent approvals in America. F. F. Hand, 1117 South 60th Street, Philadelphia, Pennsylvania.

STAMPS—12 different from warring nations, 10c; 19 different foreign coins, 25c; 10 Uruguay stamps for 10c. Lists free. Toledo Stamp Company, Toledo, Ohio.

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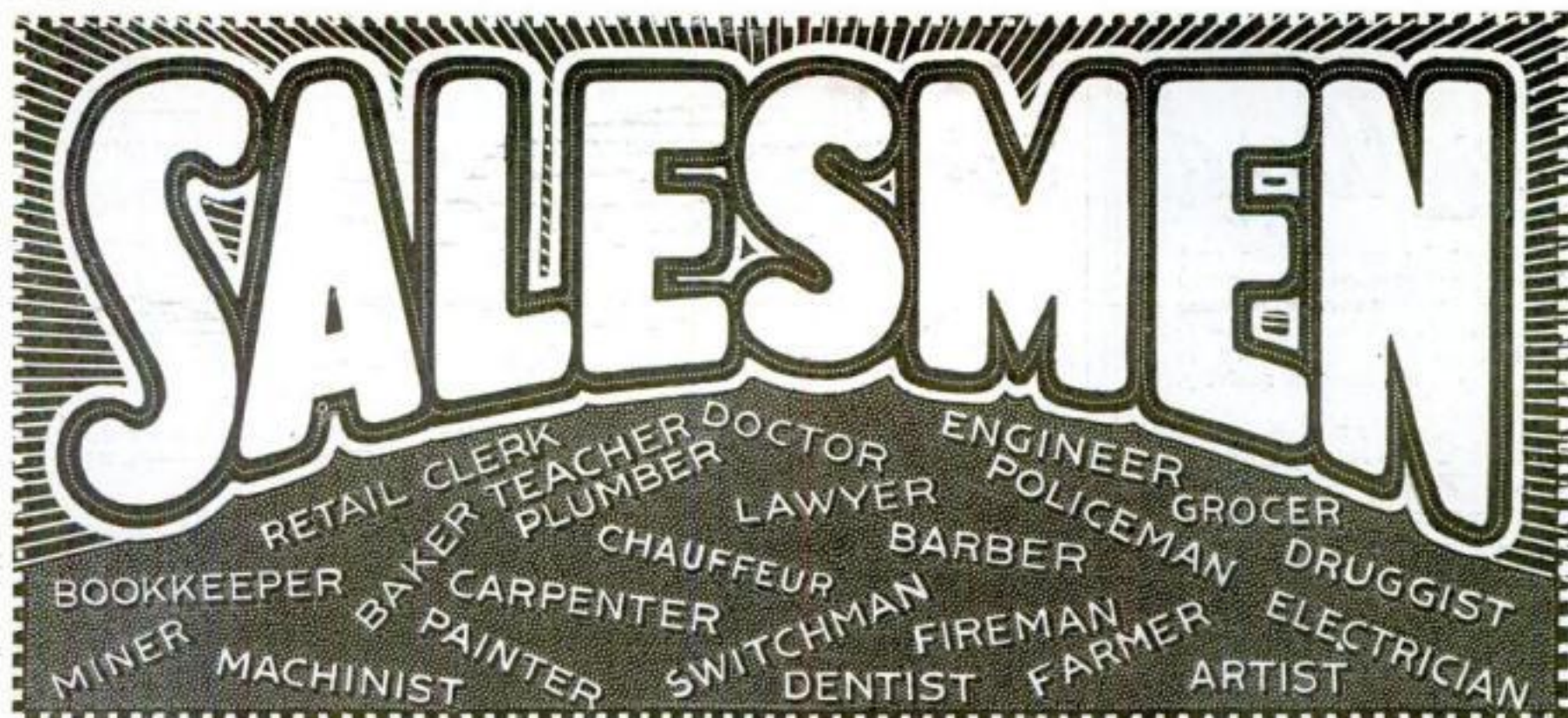
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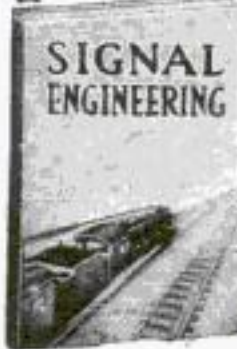
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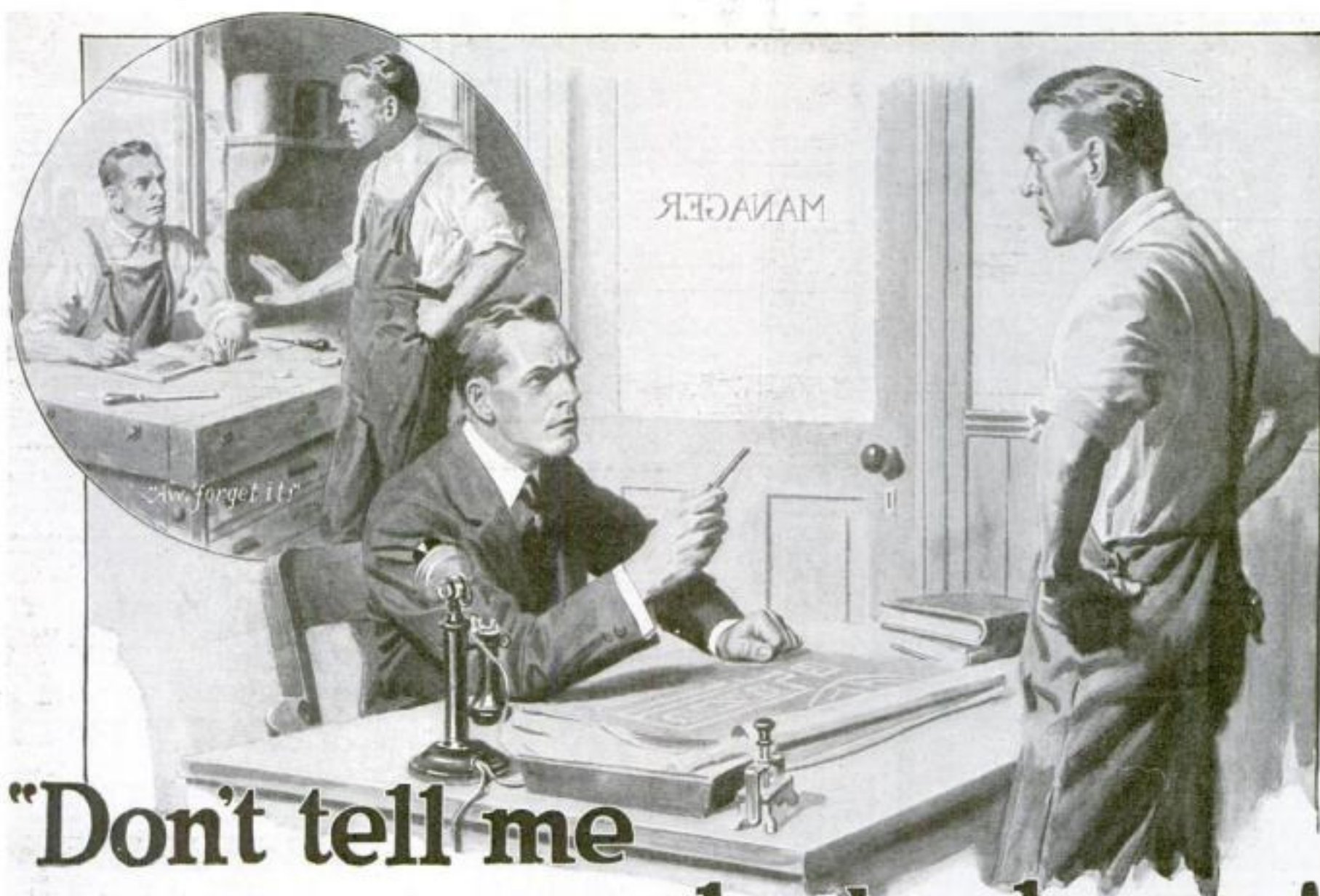
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Freezing, hawking, spitting and coughing. Why do you have catarrh anyway? You were not born with catarrh—you contracted it. This offensive, unwholesome, disagreeable complaint fastened itself upon you and grew. Nature in trying to prevent more serious consequences due to the congestion in your body, finds an outlet for the accumulated waste, by way of catarrh. You cannot get rid of it the way you are going—sprays, lotions, snuffing powders, drugs and medicines won't stop it. You know catarrh leads to other troubles—serious ones—throat, lungs, stomach, intestines—all become affected. You can never enjoy good health if you have catarrh; you won't be efficient in anything as long as you have catarrh, and it detracts from your personality to be hawking and snuffing around others.

BUILD YOURSELF UP

Be clean—Wholesome—Healthy—Vital. Go at it the right way—Nature's way; no drugs, no medicines, and you banish catarrh from your system. Let me show you how by my method of health building, body developing, called

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Its practice never fails—it builds new tissue, gives brawn and muscle; it invigorates heart action, strengthens kidneys, and makes the bowels move by their own natural strength; it makes every organ in your body pulsate to health. Under this kind of influence, catarrh quits for good, so will constipation, indigestion, nervousness, palpitation, rupture, rheumatism, weak heart, poor memory, physical weakness, vital losses, short wind, and all sorts and kinds of ailments and disorders.

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A Personal Message

From E. J. Sweeney

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We have added to our already magnificent equipment the famous Liberty Motor, the Hall-Scott Motor, the Sturtevant, and the Hispano-Suiza Motor.

As you know, these famous and enormously expensive motors were used by the United States Government in aviation service.

You have all heard about the Liberty Motor. This is a twelve-cylinder V type with overhead valves and overhead cam shaft. It develops 440 horse power and weighs 890 pounds. The Liberty Motor consumes 36 gallons of gasoline per hour on open throttle and 1½ gallons of oil per hour.

Now you cannot be a first class mechanic without being able to handle this motor, and at no other automobile school in the world can you find it but at Sweeney's.

But the Liberty is not all the new aviation equipment we offer for your instruction.

There is the Hall-Scott Six, the Sturtevant Eight, that develops 200 horse power, and also the famous Hispano-Suiza, 120 horse power with 1450 R. P. M.

How many of the best mechanics in your states know anything more than the names of these motors? Yet each and every Sweeney student works on these latest models until he knows them backward and forward.

It is this sort of work by the "Sweeney System of Practical Experience" that turns out real experts—men in demand for big jobs at big salaries.

COME TO THE SWEENEY SCHOOL OF Auto, Tractor and Aviation Mechanics if you really wish to be a trained Expert and to work on the most modern machinery

FACTS ABOUT THE SWEENEY SCHOOL.

Only automobile school in the world owning Liberty Motor, Hall-Scott, Hispano-Suiza, and other government equipment.

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THE SWEENEY SYSTEM

cannot be obtained anywhere else, just as Sweeney's Equipment cannot be duplicated any place else. Learn how to repair or make any piece of machinery by doing the work with your own hands under the personal instruction of experts. Train hand and eye and brain together until you do the job right. This is the celebrated Sweeney System that has turned out over 30,000 graduates and which was approved by the United States Government in sending me 5,000 men to train for army mechanical service. The idea that has built a Million Dollar Trade School and made thousands of men a success in life.

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"Make that step in the right direction. Come to the recognized leader. I want every young man mechanically inclined to make a real start this year. **Begin today** by sending for my big, free catalog. You don't need any previous experience, or any education, because we use tools, not books. In fact, I have a wonderful testimonial from a deaf and dumb student whom I trained in eight weeks. By sending for my book, you incur no obligation, you simply give yourself the opportunity of investigating the wonderful possibilities the automotive business offers you.

I say it is the greatest opportunity in the world today, and my free book tells all about it. So mail the coupon NOW and get the FACTS."

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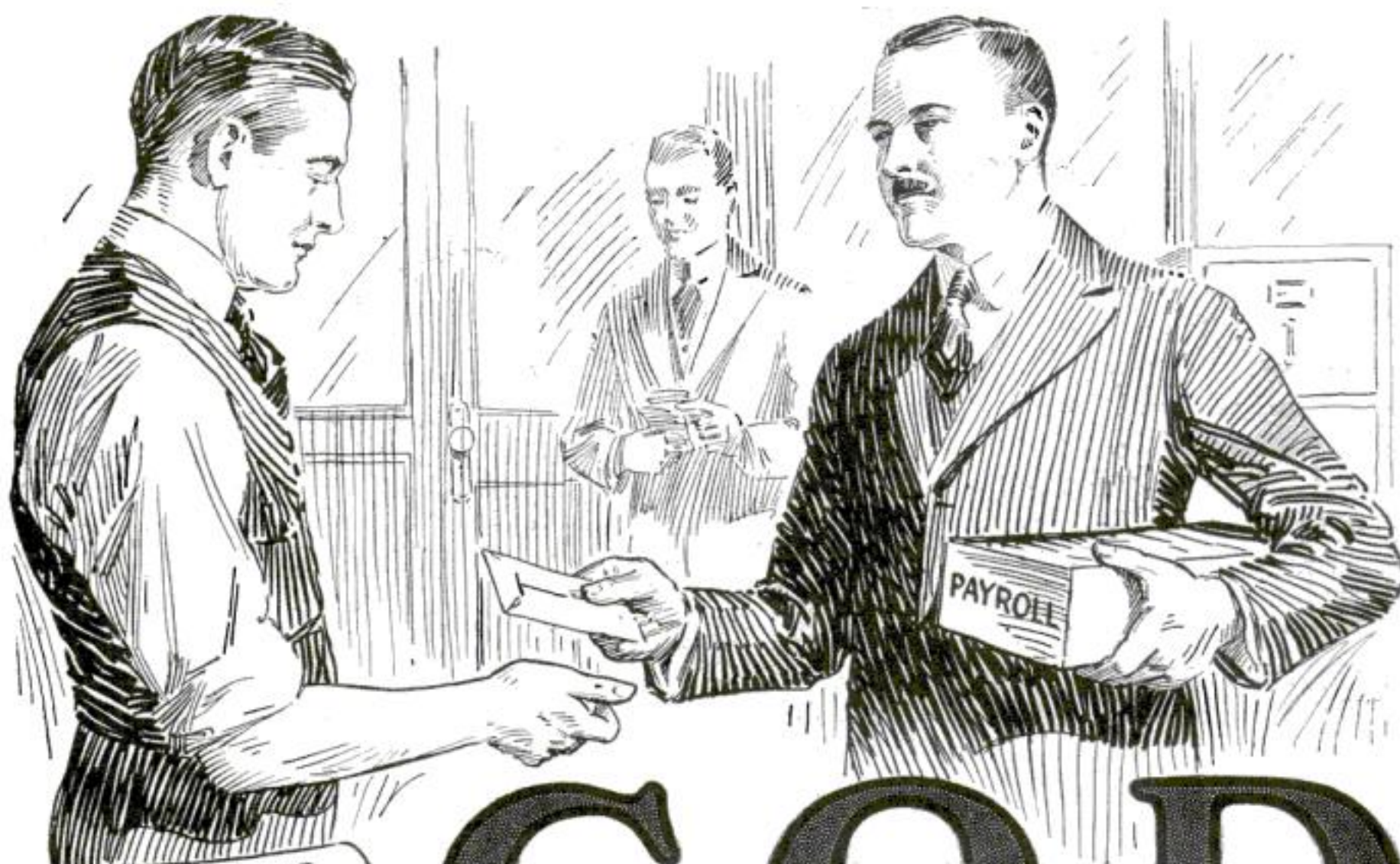


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C.O.D.

Did it ever occur to you that all salaries are paid on a C. O. D. basis—*cash on delivery*? It is the only plan on which salaries can be figured, otherwise business would be very uncertain.

A man who is only worth \$25 a week cannot expect more until he can *deliver more*. The man who can deliver service worth \$75 or \$100 a week to the boss expects it—and gets it.

To the fellow who has never stopped to think the matter over it must seem that the men who draw big pay are either "lucky" or have a "pull." Nothing is further from the truth, for "luck" and "pull" cut no ice on any payroll.

The amount on your pay check represents in cold figures just how much you are worth on the market—how much you know and *how much you can deliver*.

The men who are at the top of the payroll are there because they fitted themselves to deliver the service they are drawing big pay for. This is all you have to do to increase your pay.

RAISE YOUR OWN PAY

You can raise your own pay by increasing your delivery of service. You can easily do it—just as thousands of American School students have done—by devoting a part of your spare time to practical training. One

hour after supper each night will do.

Employers won't show workers how to deliver more—but they are willing to and do pay real money to those who know how to deliver a maximum of service.

We know we can increase your delivery and are willing to guarantee *our service to satisfy you* or we will *refund your money in full*. Take ten lessons before deciding whether you wish to continue. You risk nothing, so let us know in the Coupon in which line you want to deliver more—and earn more.

American School of Correspondence
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TRAINING—THE KEY TO SUCCESS

Please tell me how I can qualify for the position marked X.

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|Airplane Mechanic |Bookkeeper |
|Electrical Engineer |Stenographer |
|Electric Light and Power |Fire Insurance Expert |
|Superintendent |Sanitary Engineer |
|Hydroelectric Engineer |Master Plumber |
|Architect |Heating and Ventilating |
|Building Contractor |Engineer |
|Civil Engineer |Gen'l Education Courses |
|Structural Engineer |Com. School Branches |
|Mechanical Engineer |Lawyer |
|Shop Superintendent |Telephone Engineer |
|Steam Engineer |Western Union Courses |
|Draftsman and Designer |Wireless Operator |
|Photoplay Writer |Employment Manager |
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Name

Address

THE BUSINESS VALUES OF PELMANISM—By George Creel

PELMANISM is able to guarantee advancement and increased incomes for the very simple reason that it gives workers the qualities that employers are hoping for and searching for. Salary is no longer the determining consideration: the main thing is intelligent service.

One of the country's greatest executives speaking recently to the writer, made this statement:

"For every efficient man or woman, there are ninety-nine inefficients. Stenographers who listen with one ear only secretaries who can't remember, clerks who keep their eyes on the clock, department heads who are afraid to make decisions of their own, superintendents utterly lacking in initiative and originality—nearly all of them a wool-gathering lot without ability to concentrate on anything but quitting time. Not one in a hundred with any real interest in their work beyond doing as little as they can for the money they get."

The same complaint comes from the trades and professions. Carelessness, laziness, and indifference, instead of intelligent enthusiasm, driving purpose, and quick thinking. A willingness to "stay put" instead of the eager ambition that fairly begs for new opportunities and larger responsibilities. As a result, employers of every kind are the hunters today, scouring the country in search of men and women who can "deliver the goods."

The Master Words of Modern Life

INIITIATIVE! Imagination! Personality! Good judgment! Originality! These are the master words of modern life, and it is precisely these qualities that Pelmanism develops, strengthens, and directs. It opens your mind for inspection, letting you see wherein you are strong, wherein you are weak; and, even as it adds to strength, so does it correct weakness.

Where the average employer makes a mistake is in assuming that inefficiency is willful and premeditated. He is convinced that his employees do not want to give good service and to have real interest in advancement. This is true in very few cases. The general run of working men and women have no desire to cheat, most of them have their hopes of holding places of power and distinction, and all of them want to earn more money. The trouble is that they express themselves in day-dreams and not in action.

When analyzed, this is seen to be a misfortune, not a fault. How can they listen when they have never been taught concentration? How can they have initiative and originality, when our educational system tries its best to turn pupils into parrots and have them all uniform in type? How can they have purpose, and hold to it, when our life ignores the fundamental truth that the human mind has got to be exercised in order to be fit and stay fit? As a matter of fact, the majority of workers are doomed to day-dreams because their training, or lack of it, has robbed them of their mental teeth. They can't take hold and hang on. The mind, unused to continued effort, tires quickly and jumps from one thing to another like a grasshopper.



GEORGE CREEL

Pelmanism Trains the Mind

PELMANISM does the simple, obvious thing. First of all, it teaches self-realization. Very few people really know themselves. They imagine they are this or that, and blunder through life the victims of their own ignorance. In the second place, Pelmanism trains the mind, exercising it scientifically, meeting its new strengths with new tests, until, at the end, there is perfect balance, full power, and an amazing endurance.

Another great mistake, and one made generally, is the assumption that business is a purely mechanical process.

There is, on every hand, a general, well-grounded belief that business calls for the hard qualities, not the fine ones—that it is a thing of routine, not a drama of inspiration.

As a matter of fact, modern business is an organization as interesting as it is vast, and its operations make steady and imperative demands upon every mental quality. Not a day passes that its generals, captains, and corporals are not called upon to bring the functions of the mind into instant operation at high pressure. Routine efficiency is not enough.

The call is for the quick, leaping brain that is able to create ideas, to find fresh viewpoints, to make decisions as logical as they are swift, and to manufacture opportunities, instead of waiting for them. Imagination, courage and resourcefulness are as much tangible assets as stocks and bonds, for business today is not a "church social," but a battle.

Pelmanism Develops Business Power

BUSINESS is the Great American Romance. It is business that has harnessed the stream, tunneled the mountain and the river, turned deserts into orchards, and made the United States the world power in one hundred and forty-three years. It calls for the best and it deserves the best. It is this best that Pelmanism develops, trains, and directs.

Business needs the whole mind, not just part of it. It is often the case that a man of vision, forethought, initiative, resource, courage, and confidence is forced to confess that he has "no head for detail." On the other hand, masters of detail "fall down" when the big problem comes along.

The fault in each case is an incompletely developed mind, a mind which has been developed on one side but not on the other.

The Pelmanist finds no difficulty in assimilating detail and he rises supreme when big issues confront him. His training gives him the balanced mind, the alert mind, the mind that is receptive and responsive. And that is just the type of mind which achieves success with almost miraculous ease while other men lag behind, puzzled, confused, and inert.

Go Forward or Go Back

THE appeal of Pelmanism is neither narrow nor specialized. The beginner will find the secret of promotion in it. The veteran "job holder" will get from it new courage, self-confidence, and a resourcefulness that will lift him above his fears and out of his ruts. Executive heads will discover that Pelmanism takes up "mental slack," tones up the mind processes, and acts as a tonic to vision, decision, and imagination. Business permits no stand still. Those who do not go forward commence to drop back.

This great course comes at a great time. Never before in the history of American business were such chances open to intelligent ambition. Old barriers are down, the gates of success swing wide, and the ranks of the country's workers are being combed for the "right sort."

(Signed) GEORGE CREEL.

Make Yourself That "Right Sort"!

MAKE yourself a Pelmanist. Do for yourself what 400,000 other men and women have done—put yourself in a mental position not alone to grasp opportunity when it comes, but to make opportunity come to you.

Pelmanism is neither an experiment nor a theory. It has stood the test of twenty years. Its students are in every country in the world. Its benefits are attested by hundreds of thousands of men and women in all walks and conditions of life.

Pelmanism is taught entirely by correspondence. There are twelve lessons—twelve "Little Gray Books." The course can be completed in three to twelve months, depending entirely upon the amount of time devoted to study. Half an hour daily will enable the student to finish in three months.

Send for "Mind and Memory" Today

THE booklet is free. Fill out and mail the coupon or a postcard—today—now—before you forget it. Take your first lesson in the rudiments of Pelmanism—don't procrastinate—decide to do a thing and then do it—now, not later. Write to Pelman Institute of America, Suite 325, 505 Fifth Avenue, New York.

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Popular Science Monthly

Waldemar Kaempffert, *Editor*

March, 1920; Vol. 96, No. 3
25 Cents a Copy; \$3 a Year



Published in New York City at
225 West Thirty-ninth Street

A Flying-Boat that Sheds Its Wings

Changing from bird to fish if compelled to alight at sea

WHEN you fly to New York from England across the Atlantic ocean, everything depends on the engines. So long as they run you skim the clouds in safety. If they stop, down you must glide to the sea. Motion is the secret of an airplane flight—incessant motion.

Do you remember Hawker's mishap? Do you remember how nearly he lost his life in a heavy sea, because a

passing tramp steamer found it difficult to reach him? To be sure, his was a land machine—doomed if ever it was compelled to alight on the heaving billows.

The transatlantic airplane of the future will probably be a flying-boat. If its engines fail, it will alight on the surface of the water and float. The wings will then become a handicap, particularly in a storm. A sailing ship

in a storm scuds along, either close reefed or under bare poles. The enormous expanse of wing of a flying-boat as it floats may imperil the passengers. Why not shed them altogether? That is the solution proposed by Mr. Glenn H. Curtiss and one of his engineers, Mr. William L. Gilmore.

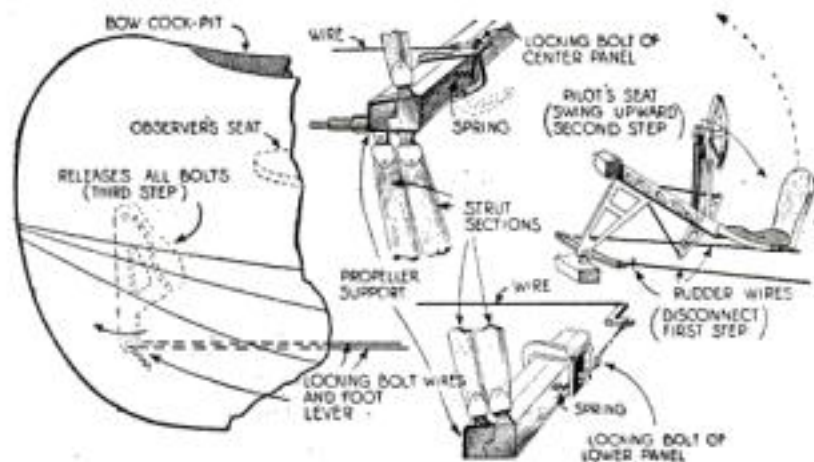
Examine the accompanying drawings and you will see how Mr.

Curtiss and Mr. Gilmore could rid a flying-boat of its useless wings.

In the first place, there is a very staunch, seaworthy hull, provided with bulkheads and water-tight compartments. In that hull an engine is mounted which drives aerial propellers; there is also an auxiliary engine, which drives a water propeller.

The wing structure to be shed consists of a triplane, secured to the back of the hull by means of a saddle. Pull a lever and the saddle is released so that the wings and outrigger tail (supported from the wing cell only) slides back on rails from the stern of the boat.

The wings are to be shed with the aid of the aerial propellers. But suppose the engine is dead? The wings can nevertheless slide back because of the inclination of the trackway and the propulsive effort derived through the water propeller. The wind literally blows the entire wing structure away when it is released, leaving the boat free to ride the storm.



To shed the wings the pilot in the rear cockpit disconnects the rudder wires, pulls up the wing controls and pilot's seat to a position above deck, and climbs to a position of safety. The observer forward unfastens the holding bolts and the wind from the propellers blows the wings overboard



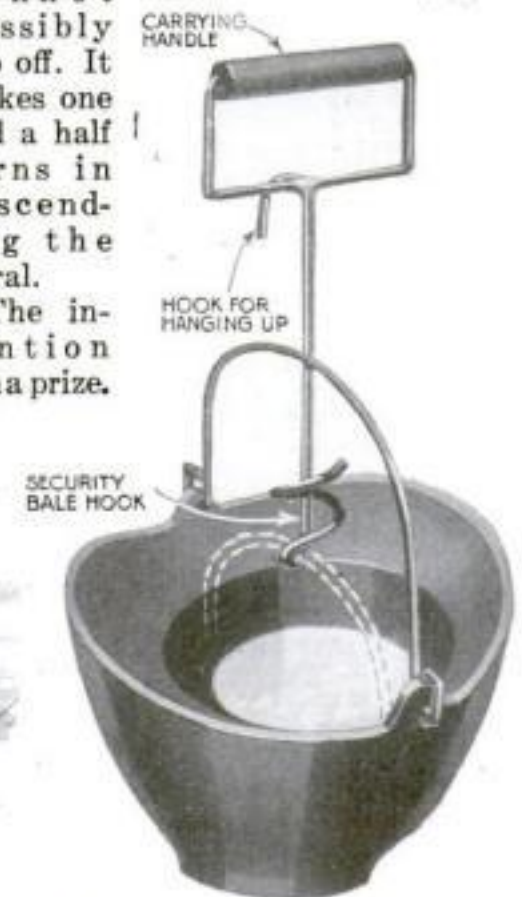
Changing from bird to fish in mid-ocean is the work of only a few minutes for this biplane

A Hook that Holds the Solder-Pot Securely

LOOK out!" shouted one of the linemen who were occupied with a soldering job. The next moment the solder-pot upset, and the man who was holding it narrowly escaped a bad burn.

William Nieswinter, a foreman in the employ of the Commonwealth Edison Company of Chicago, saw this incident happen so often that he devised the safety pot-hook shown in the picture. The hook part is made in the form of a spiral. The weight of the pot carries the bale to the bottom turn, and once there it cannot possibly slip off. It makes one and a half turns in descending the spiral.

The invention won a prize.



This safety-first pot-hook is designed to prevent burns from overturned solder-pots



The flat coal-boat is slid in between two floats having a chain-and-bucket elevator; the coal is carried to a storage bin above and fed to a belt conveyer running to shore

Mining Coal from the Bottom of a River

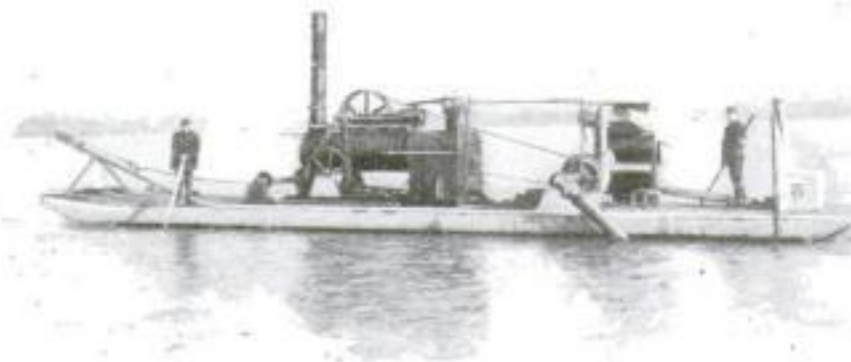
IN the anthracite coal regions of Pennsylvania, a great deal of fine coal from the culm banks is washed down the streams at times of flood, forming extensive beds of coal. This fine coal can, with modern methods of combustion, be used very satisfactorily in steam plants.

Along the Susquehanna River coal fleets are very much in evidence; long flat boats with stern wheels, for navigating the shallow waters, move the dredges and coal-boats. Each dredge, as shown in the illustration at the right, is equipped with a horizontal engine and boiler which drives a rotary pump that sucks the coal up from the bottom of the river.

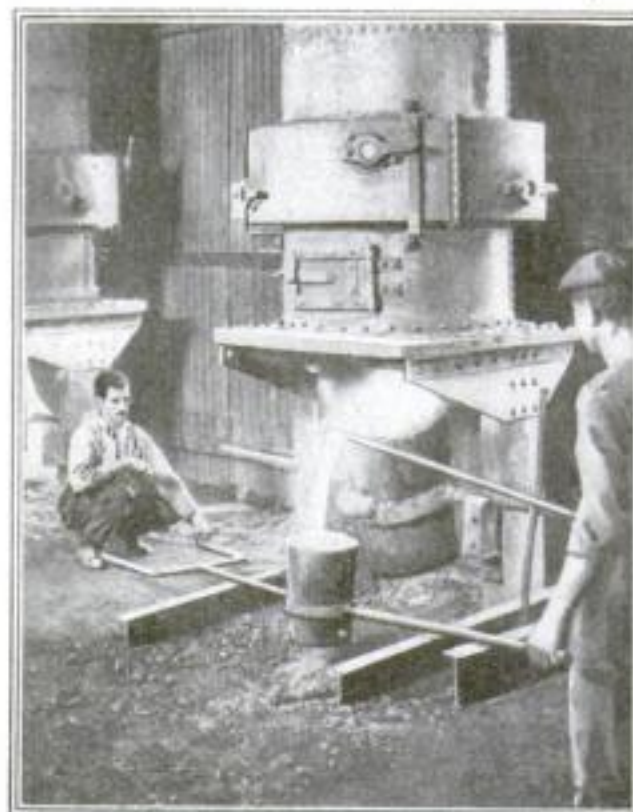
The coal is discharged against a screen through which the water and most of the sand passes, and is then dropped into a coal-boat tied alongside. The engine also drives a windlass at the bow of the dredge, which slowly winds up the long anchor rope so as to drag the head of the suction pipe slowly over the bed of coal.

When the coal-boat is taken to shore, it is unloaded by a chain-and-bucket elevator with a feeder at the lower end. This feeder sweeps up the coal across practically the whole width of the boat, so that very little is left to be cleaned up by hand. The machine will unload the coal at the rate of a ton a minute.

The elevator delivers the coal to an overhead steel storage bin from which it is fed to a belt conveyer running over to shore.



This dredge sucks up coal from the bottom of the river; then the coal is thrown through a screen on to a coal-boat



The molten iron pours from the furnace to a large bucket which tilts the liquid into a smaller one

The New Iron Bucket

WHICH is the most efficient way of getting molten iron from the furnace into molds? Many ways have been tried, but few survive. One of the chosen few is illustrated at the left. A small part of the bottom of the furnace drops out and the iron pours into a large bucket beneath it.

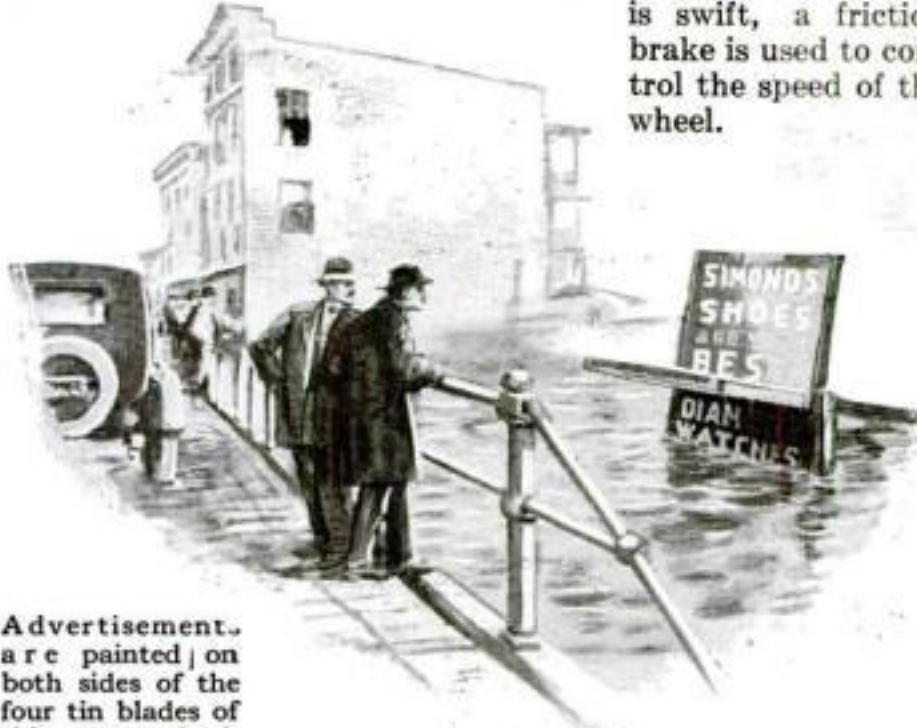
The bucket is mounted on a shaft that can be made to revolve; thus the bucket is easily tilted. A small bucket is placed in front of the large one and the iron is poured from the large to the small. The men carry away the small bucket, fill the molds from it, and by the time they get back the large bucket is full again. Two men are thus able to fill the molds rapidly and the process is continuous.

In most furnaces, when the bucket is full the flow must be turned off until another empty bucket is placed under the spout.

Advertisements on a Water-Wheel

THE water-wheel has gone into the advertising business and finds the work much easier than furnishing power to machinery. Advertisements are painted on both sides of each blade. The wheel turns over—propelled by the current of the river—and the wet advertisements shimmer forth in turn, so that all who pass may read.

Four posts are driven into the river-bed, and the water-wheel is mounted on and above them so that the tips of the blades dip into the water. If the current of the river is swift, a friction brake is used to control the speed of the wheel.



Advertisements are painted on both sides of the four tin blades of this water-wheel, which attracts considerable attention from passers-by

Wire Your Bathrobe and Keep Well

"IT'S cold!" you chatter as you come home worn out from a hard day's work. What you need is invigorating treatment, and you may easily obtain it by putting on an electrically heated bathrobe.

Such a robe has copper wire woven in with the cloth so that no two sections touch each other, thus preventing short circuit when the wire is connected to an electric circuit. The bathrobe is provided with a thermostat for regulating the temperature.

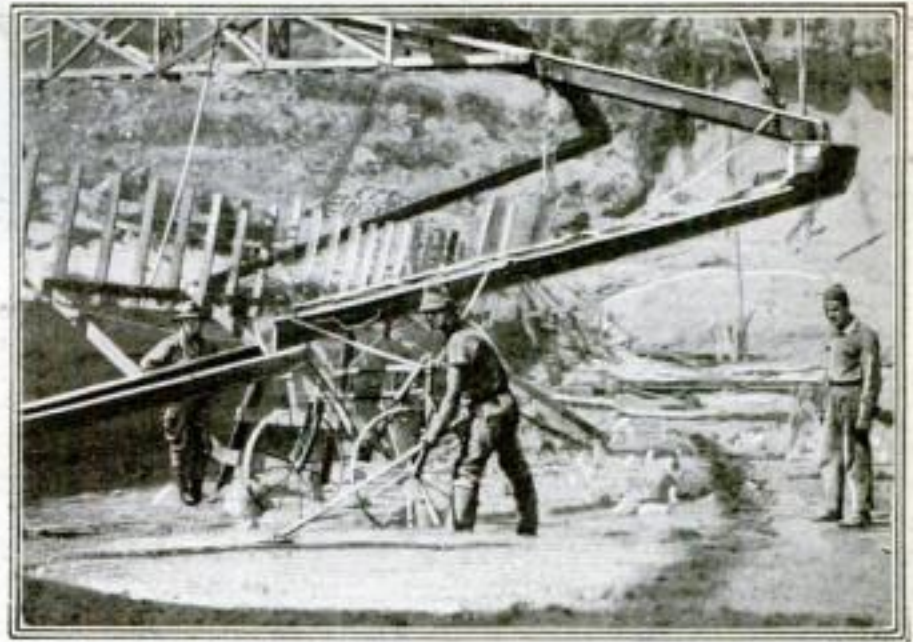
The bathrobe is the invention of Mr. Charles Cann, of Salt Lake City, Utah. It also comes in the form of a blanket. Mr. Cann invented the device in an attempt to cure his wife of rheumatism; and he tells us that it was a great success.



This bathrobe is wired; by connecting the wires with an electric socket you will find yourself greatly invigorated as the electricity warms your blood



She suffers from rheumatism, but expects to be cured soon, for she is wrapped in an electrified blanket; the wires are carefully woven in



The end of a concrete chute is mounted on a bicycle so that it can be pushed into any position desired

A Concrete Chute on a Bicycle

A CONCRETE chute goes for a bicycle ride! Sounds strange, doesn't it? But consider the problems with which a concrete chute is confronted. It must move its delivery end from place to place as the work progresses. Why not use a bicycle for the job?

This scheme was put into effect in the construction of the Gibraltar dam, near Santa Barbara, Cal. The two wheels were taken from an old buggy and were mounted on a frame made up of scrap iron and odd pieces of old pipe. The chute was fastened to the frame. The wheels were bolted so that they could be turned in any direction desired.

When the workmen wished to move the chute they simply turned the wheels to suit and pushed the bicycle by hand.



Refractory watch-cases yield to this form of persuasion in short order. A vacuum cup affords a good grip

A Vacuum Cup to Open Tight Watch-Cases

"SAY, Tom, can you open this watch-case? It's stuck tight." It was a repair man at a watchmaker's who spoke. A screw-back case was stuck and he could not get a grip on it with his hand.

To cope with cases like this a vacuum cup has been invented by Hugh C. Danner, of Martinsburg, W. Va. It is reproduced above.

The cup is made of soft rubber, and has a roughened grip around its upper rim. To open a watch, the rubber opener is pressed against the back of the case. By pressing in the top of the cup a partial vacuum is created, which causes it to adhere strongly. In this way an excellent grip is afforded and the case can then be unscrewed without any further trouble.

Fighting Fire Under Water

Water, water everywhere, but never a drop to put out the fire that threatened the lives of two divers

By Francis Arnold Collins

FEW firemen have ever faced so appalling a danger as did the deep-sea divers who found themselves trapped far below the surface of the water in a burning wreck. The submerged hull in which they worked was filled with compressed air and the abundance of oxygen made the flames spread with abnormal rapidity. Though they were literally buried under water, there was no time to wrench open the hull and let it in. Should they abandon the job?

From the first the work of salving the wreck had proved extremely difficult. The ship had gone down in quiet but deep water, and every effort to raise her with pontoons had failed. It was finally decided to close her hold and some of the superstructure and to blow out the water by compressed air.

The ship had been injured in a lower section of the hull and the work of plugging her hold was less difficult than might be imagined. Like a bottle upside down in the water, it didn't matter so much if there were a small hole or two in the lower side—the water would enter only a little way. But the holes in the top would let out any air forced in and cause the trouble.

Several days had been spent inserting strips of oakum in the openings to stop the leaks and make the upper sides air-tight. Finally the air-pumps were started. Several hours of pumping, however, failed to bring up the sunken ship.

"She leaks," decided old Bill Andrews, veteran at the pumps. "The water's gone out of them upper cabins all right, but when the air gets to pushin' the water on down into the hold, and out the bottom of the ship—why, one of them cabins is leakin' air just enough that the pressure keeps goin' down and the water don't back out only so far. We can't raise the ship unless all the water goes out. Them leaks is got to be fixed."

This statement, though ungrammatical, was entirely correct. Two experienced divers were selected to go down into the air-chamber and investigate. They wore full diving-suits.

The divers reached the hull in safety, made their way through the hole in the bottom and up into the superstructure to the point where the air had driven the water out. Candles were lighted and they started on their tour of inspection. The tiny flame was needed not so much for illumination as to show the presence of a current of air. If a leak had sprung in one of the cracks, then when the candle was held near it the flame would blow the way the air was

going—out the leak, and would indicate at a glance the location of the leak.

Clumping laboriously around in their leaden-weighted shoes and heavy suits, the men moved forward, holding the candles to the cracks. Slowly and cautiously they worked, for no one knew better than they that the air-chamber, far below the surface of the water, was ripe for a bad fire. The compressed air had dried out the inflammable materials. An enormous amount of oakum had been used in filling the seams, and the ragged ends of oakum are highly inflammable. Once started, a fire under such conditions would spread with rapidity. Even under ordinary air-pressure the oakum would quickly fan the merest spark into a blaze.

Suddenly a draft of escaping air caught the flame of the candle ahead. Before the diver could draw back, it had leaped to a frayed end of oakum several inches away.

"Fire!"

The worst had happened. There were tons of water above, below, and all around, but no time to wrench open some part of the roof or sides of the cabin and let it in. The flames were spreading with terrifying speed. Without thought of self, the men, driven to the most primitive method of defense, tried to beat out the fire with their heavy mits. Had they forgotten in their excitement another danger that threatened? The smallest hole burned through the air-tight gloves meant certain death—suffocation from the smoke that would pour into the inflated suits, or death by drowning should they attempt to leave the air-chamber. And still they fought, inviting death at every blow.

The dark chamber was lighted only by the fitful flames of the burning oakum. The heavy diving-suits made the work extremely difficult. The



Suddenly a draft of escaping air caught the flame of the foremost candle, and before the diver could draw back, it had leaped to a frayed end of oakum several inches away

movements of hand and foot

were slowed down by the weight. A blow that would beat out a flame in an ordinary atmosphere would not suffice here. Desperately they pounded and stamped, working like men in a nightmare who try to escape from peril but are held back by an invisible force. Bit by bit they gained on the swift, fierce flames, which were fed by the light oily oakum and the excess of oxygen in the air. At last pluck won.

Under the frantic slapping and stamping the last spark smoldered out.

Then only did the divers think of retreat. Their gloves, though badly singed, were fortunately intact.

Slowly they retraced their steps through the dark winding passages, until they reached the free water. With a jerk, they signaled to be drawn up.

As they crawled over the rail of the ship above, a strong smell of burnt rubber still lingered about them. Once safe above the ground, or rather the water, they sat down for a quiet smoke. Old Bill Andrews labored up a hatchway.

"Hello, what's up?" says he, hunting for his favorite oilcan.

"We are," was the laconic reply, "and if you don't mind we'll stay up."



Clad in heavy, clumsy diving-suits, the men were sent down to search for the air leak in the sunken hull



They Faced Death by Fire at the Bottom of the Sea

The hull of the sunken ship was filled with compressed air, and the abundance of oxygen made the flames spread with appalling rapidity. Though they were entirely surrounded by water, there was no time to break through the roof or sides of the cabin. But the men would not

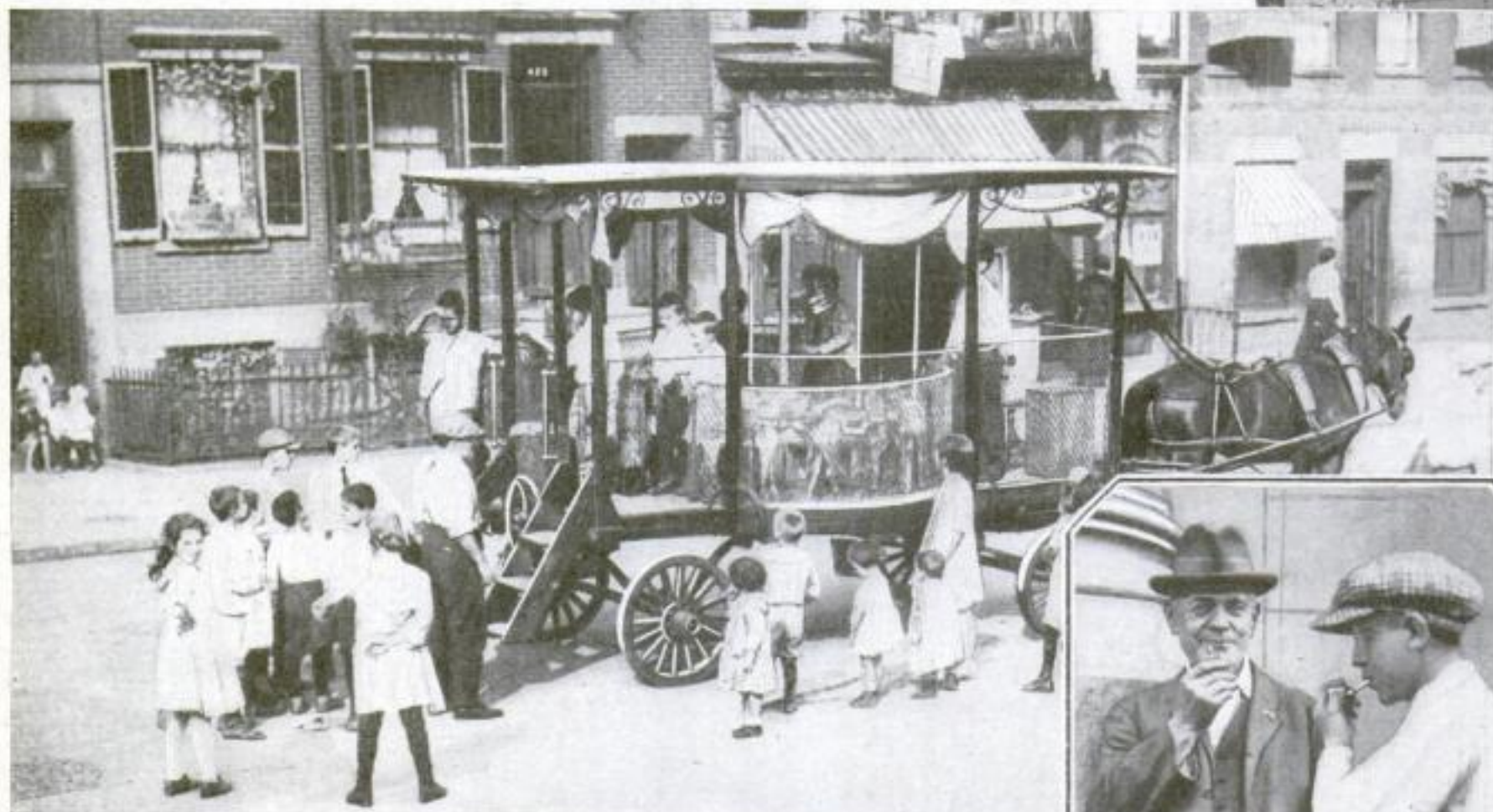
desert their job. Weighed down by their clumsy diving-suits, which made every slightest movement an effort, they fought back the flames with their hands. One small hole burned through their inflated rubber suits meant death by either suffocation or drowning

How to Earn a Living

If you don't like your job,
why not try one of these?

Photographs © Press Illustrating Service

This man has mounted a telescope in Battery Park, New York, and he charges five cents a look. By day the people look at the sun and by night at the moon



From street to street he travels with his merry-go-round, charging one or two cents a ride; the children ride the small horses that go round and round while a tin-panny piano plays a tune



He whistles for a living; yes, he really does. And when you hear the birdlike tune you promptly buy one of his whistles. He stands on a crowded corner and works industriously all the day long



Collar buttons are this man's specialty; he stands on the corner buttoning and unbuttoning his collar while a crowd gathers round and watches him. He demonstrates the superiority of his particular collar button, and sells many like it



"Umbrellas to mend!" This man shouts through the streets while he carries on his back the mending-machine. His customers are many, for umbrellas, like everything else, have gone up, and it's much cheaper to have your old one mended than to buy a new one

Noise for the Silent Drama

Parrots shriek, lions roar,
airplane motors hum —
all from the orchestra pit

Photographs © International Film Service



He's got his hands full of instruments for imitating birds. When Mary's pet gets a close-up, be it a parrot or a canary, Mr. Manne reaches over, picks up an instrument, and soon the theater is filled with the singing or chattering of birds, as the case may be



They look like frying-pans and saucepan lids, but they are only some of the gongs that hang on the wall; Mr. Manne sits with his back to them and simply reaches up when Chi Chu, the Chinese dope dealer on the screen above, pounds for his servants

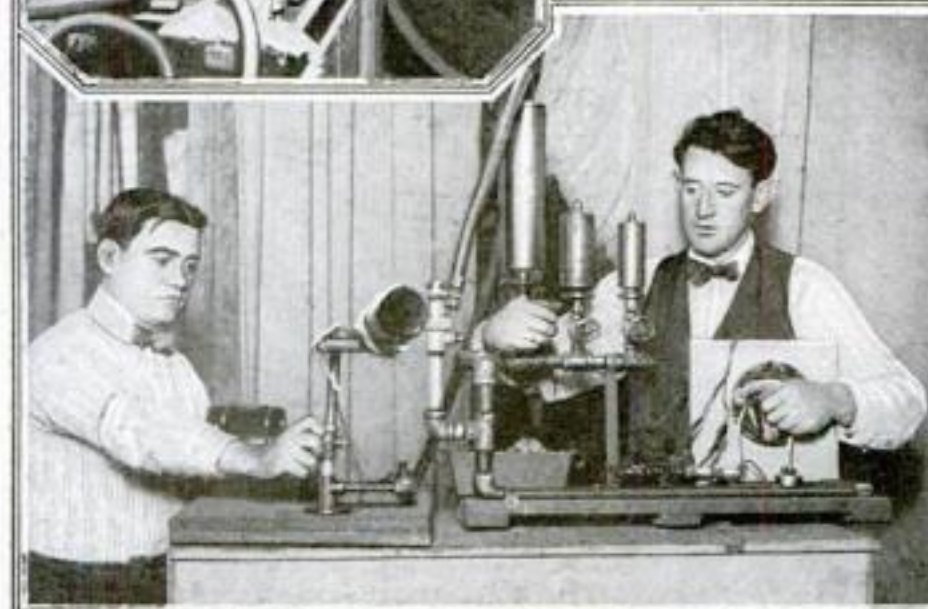


Poor Nell, the outcast, sank to the ground exhausted; the rain poured down, the lightning flashed, and the thunder growled ominously. And this is what happened behind the screen: one man made the thunder, another flashed the lightning, and a third imitated the rain



And the villain still pursues her—on horseback; whereupon Mr. Manne gets out his two imitation hoofs and plays a tune with them on a board, keeping time with the horse on the screen

The musical director can order the "Anvil Chorus" any time he wants to; Mr. Manne keeps a hammer and a good sized anvil down in the pit with him all the time



Train whistles and automobile horns are not easy to imitate; an electric circuit is involved and two men are usually needed to run it; the man to the left is getting ready to let off a shrill one



You might think this a hardware store; in reality it is the drummer's end of the orchestra pit of one of New York's largest moving-picture houses; Mr. Max H. Manne, the man in the case, performs on over three hundred instruments



This is an electrical machine used for thawing the ground in Alaska, where a railroad was to be built

Where's the Collar Button?

DOWN on his knees, the man in the picture below looks under the chairs, under the table, under the bed. Is he hunting for a burglar? No, oh no! He is only looking for a collar button that slipped out of his fingers and rolled away. In his haste to find it he took his clean collar with him and is wiping the floor with it.

Such disasters are not necessary if you use the collar button recently invented by Frank Cadden of Chicago. It comes in shape no bigger than an ordinary collar button, but it is heeled with rubber and has a decided center of gravity due to a lead disk that fits into the base. Should you drop the button the lead weight

would insure its landing right side up and the rubber base would keep it from skidding. Thus you would find it at your feet.



He's looking under the bed for his collar button; if he had used one of the new weighted buttons it would have fallen at his feet and stopped there



Thawing Ground by Electricity

AN electrician connected with the Alaskan Engineering Commission has fitted up a thawing-machine that can be used to prepare the ground for pile-driving or excavating wherever electric power is obtainable.

A steel pipe, equipped on its interior with a resistance coil, is fitted at one end with a sharpened steel point and at the opposite end with a solid steel driving-head. There is an insulated electrical connection with the enclosed resistance coil. The pipe is driven into the frozen earth to the desired distance and connection is made with the power transmission line through a portable transformer station mounted on a sledge, as shown in the illustration.

The voltage of the current is reduced and the amperage greatly increased. The resulting heat generated in the resistance coil is communicated to the enclosing steel of the pipe, and radiating therefrom thaws the surrounding earth. The water from the thawing ground cannot reach the resistance coil and hence its temperature is not reduced. In a comparatively short time the ground is sufficiently thawed to permit the withdrawal of the driven pipe and the introduction of a wooden pile, which is readily driven to the desired depth.



One man can work this saw; he pulls on his end and a spring jerks the saw back

Lighting Up the Tight-Rope Walker

THE tight-rope walker flashes on and off as if he were a lighthouse. At each step the buttons on his breeches flash on and off—they are colored electric light bulbs.

His shoes have metal toes and heels that close an electric circuit every time the walker has both feet on the rope at once. Wires run up his legs to the buttons and his feet are enclosed in non-conducting shoes.

The tight-rope is wired in sections so that alternate sections are a continuation of each other.

The wire that carries the current is wound around the rope and is so arranged that there are many contact points.

The Spring Is the Other Man on This Saw

IF you will look toward the bottom of the photograph above you will see a saw attached to the end of that bar on the left. The center of the saw is embedded in the trunk of the tree and the opposite end rests in the hand of the workman.

He is sawing down the tree by himself—or, rather, with the aid of a spring. As he pulls on the saw the anchor-shaped device on the top of the stand is swung unwillingly to the left—the spring tries to hold it back. As the man finishes a stroke he releases the handle of the saw and the spring promptly contracts, making the cut in the opposite direction.

This saw was invented by Charles A. Moore, of Kinney, Minn. It happened this way. He was a boy at the time of the Civil War, living in Virginia, and when the men left to go to war he had to hold down a man-sized job in the fields, and take a turn at the wood-pile "with an old wabby bucksaw and a dull ax."

Many years later he drifted back to his old boyhood home, and there, to his great surprise, he found the same old ax and saw in operation. Astonished at the lack of progress, he built the saw shown above.



The electric light buttons on his breeches flash on and off, for metal heel and toe contacts are continually opening and closing a circuit

Rope Shoes Made by a Sailor

THE Peabody Museum at Salem, Mass., harbors a pair of rope shoes. They were worn many years ago by a sailor on a whaling vessel. He used them to keep him from slipping on the greasy decks. The shoes, which are now badly discolored, were originally made of manila rope.

They are shaped very much like the regulation Indian moccasin and look as though they were easy to make. They might still be useful on the modern steam whaler, for whale oil has lost none of its ability to make the deck of a vessel a very good substitute for a skating-rink.



© International Film Service

Raising bees in order to conserve the sugar in flowers that is ordinarily wasted

Better Keep Bees

SUGAR is increasingly scarce and expensive; yet right around us there is an almost unlimited source of it going to waste—the flowers. The bee will gladly gather it for you if you provide it with a hive.

Students at Harvard College have built themselves simple hives like the one shown above and have got as much as thirty pounds of honey from a hive in the rush season.

Of course, some honey should be left for the bees.



These rope shoes were worn long ago by a sailor on a whaling vessel to prevent slipping on the oily deck



© International Film Service

A red light on his head and white lights on his shoulders guide the traffic

A Lit-Up Policeman

WHAT'S that red light ahead? You wonder. It's in the right place for a traffic post, but it moves! As you reach the corner you see that the light is on a policeman.

A lit-up policeman is shown above; he has a red light on his head and two white lights on his shoulders. He wears a pair of long white gloves on his hands, two white straps across his chest, and carries two batteries in his overcoat pocket.

This particular policeman regulates traffic at a corner in Boston.

Testing Building Materials by Fire

IF you wish to ascertain whether a building is fireproof, set it on fire. This method is thoroughly reliable but unsatisfactory for obvious reasons.

The modern method is illustrated by the accompanying picture. In a large open space small buildings are erected from the material to be tested or incor-

porating such material under conditions similar to those surrounding them in actual practice. Then they are set on fire and allowed to burn for a certain period. The behavior of the material during the fire is carefully observed and its resulting condition noted.

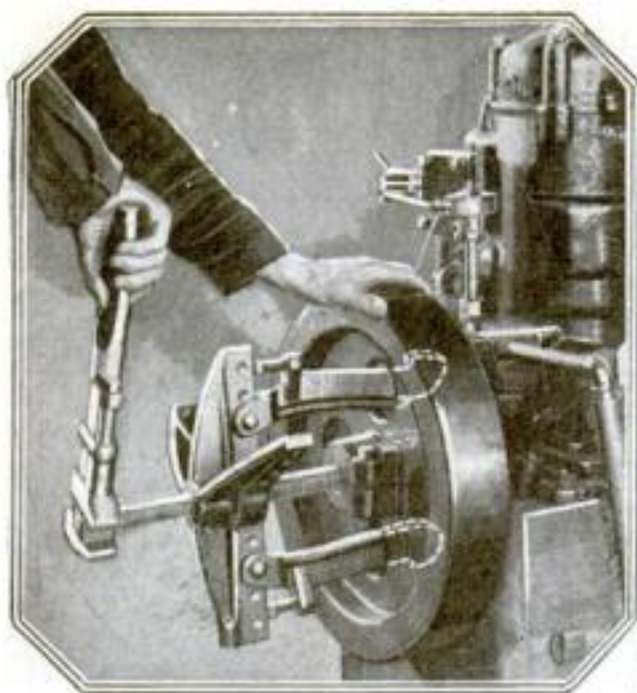
Iron, steel, stone, brick, cement, and

other building materials are thus tested. By the same method the effectiveness of fireproofing materials is practically demonstrated and information collected as to the effects of extreme heat on the supporting power of iron, steel, concrete, or stone columns, beams, trusses, and other structural units.



This shows a place where incendiarism is legitimately practised by the proper authorities for the purpose of testing the resistance which iron, steel, stone, brick, cement, and other building materials have to fire

Making Repairs Without Getting Under

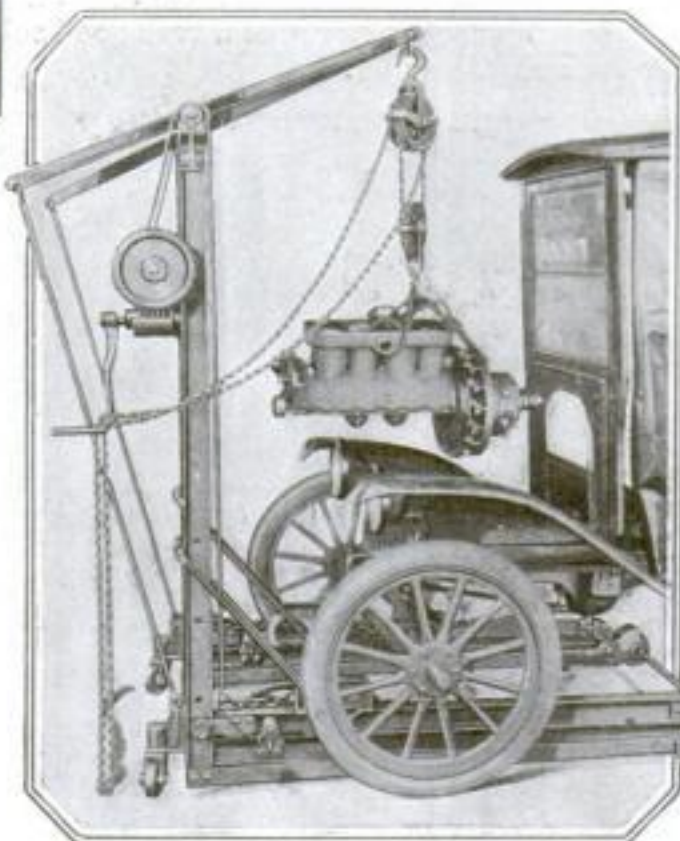


The puller with its spiderlike framework grasps the flywheel and forces it from the shaft by means of set-screws which are tightened

To Remove Flywheels

THE simple puller shown above was devised to remove an automobile or motor-boat engine flywheel.

The hooked rods are pivoted to the spider arms and their other ends made to grasp the flywheel in the most convenient location; the set-screws on the rods are then tightened up against the spider arms; the center bolt is screwed down through its boss until it touches the end of the flywheel shaft and the bolt is then turned with a monkey-wrench until the flywheel is forced off.



With the addition of the boom arm it can be used as a crane for lifting all sorts of things in a repair shop

the parts underneath without lying on his back. Furthermore, with this machine an engine may be overhauled without taking it from the car; for by removing the lower half of the crank-case and lifting the front end of the car, the main and connecting rod bearings can be examined just as easily as if the motor were removed and placed on an engine stand.

The machine consists of two metal uprights and two horizontal arms, both suitably cross-braced to form a self-supporting stand, which is further braced by two additional telescoping or oversliding arms fastened to the far ends of the two horizontal members and to the tops of the vertical bars. The front end of the vehicle is lifted by means of cables attached underneath the axle, the cables being wound up on drums hung from the vertical bars and operated by crank handles.

A crane-boom attachment forms a part of the outfit and may be installed in a few minutes' time. The stand is mounted on rollers so that it may easily be moved from job to job as desired.

The One-Man Ford Top Is Here

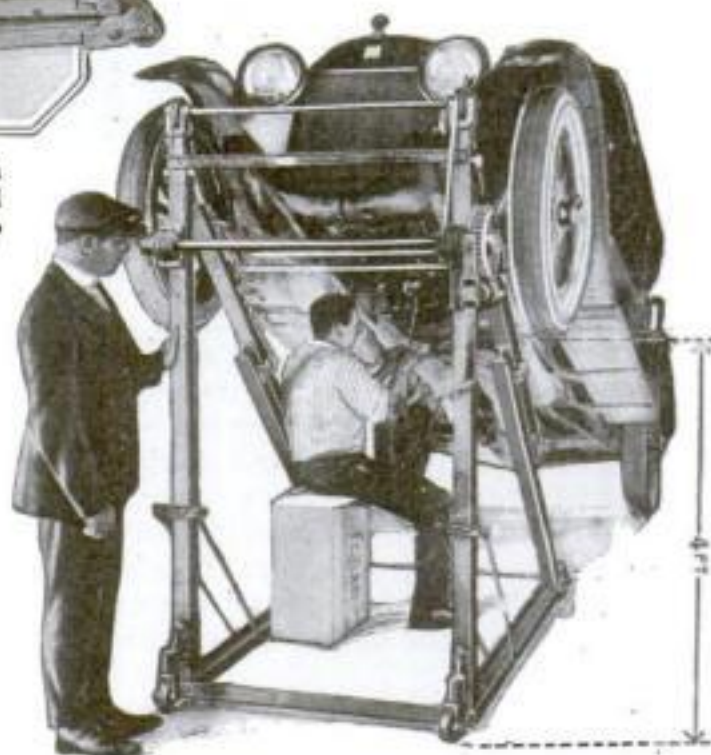
NOW comes a converter to change the old-fashioned Ford top into a one-man design. The old top and all of its fixtures are retained except the unsightly front bow sockets, which are discarded.

The converter connections, which consist of two side truss rods extending from the rear bows to the front of the windshield, and two vertical rods clamped to the sides of the windshield, are out of sight when installed and should outlast the car itself.

A good point about this converter

equipment is that it costs less than ten dollars and may be installed in about an hour's time without the use of any special tools.

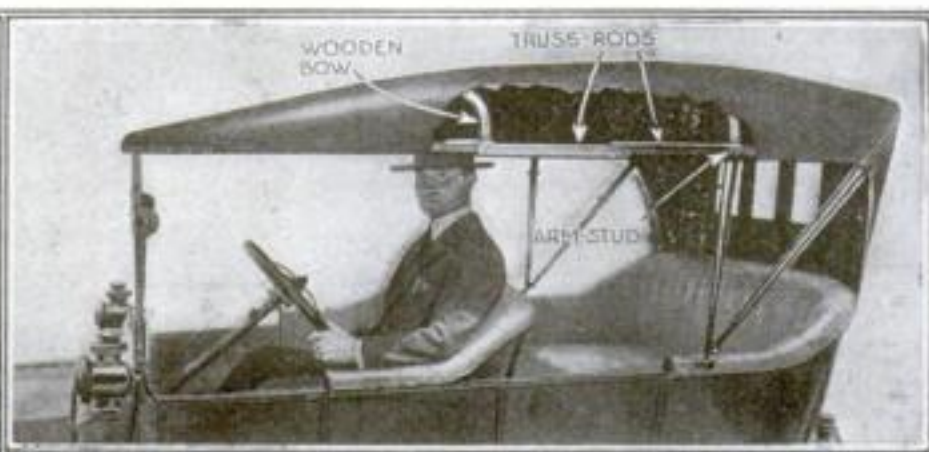
It has a number of improvements over the old top; it can be manipulated by one person; makes it easier to enter or leave the car; permits an unobstructed view at the sides; allows the driver greater freedom of the elbows; and gives the old top a streamline effect, thus making the body appear longer.



The machine so elevates the front of the car that the mechanic may easily work under it without having to lie down



Here is the old style top, where one has to duck to avoid the cross-piece when admiring the scenery or getting out of the car; certainly a rather awkward arrangement



This contrivance attached to the Ford top converts it into a one-man design which can be raised or lowered at will. How clean-cut this is compared with the car at the left

At Home Even on the Links

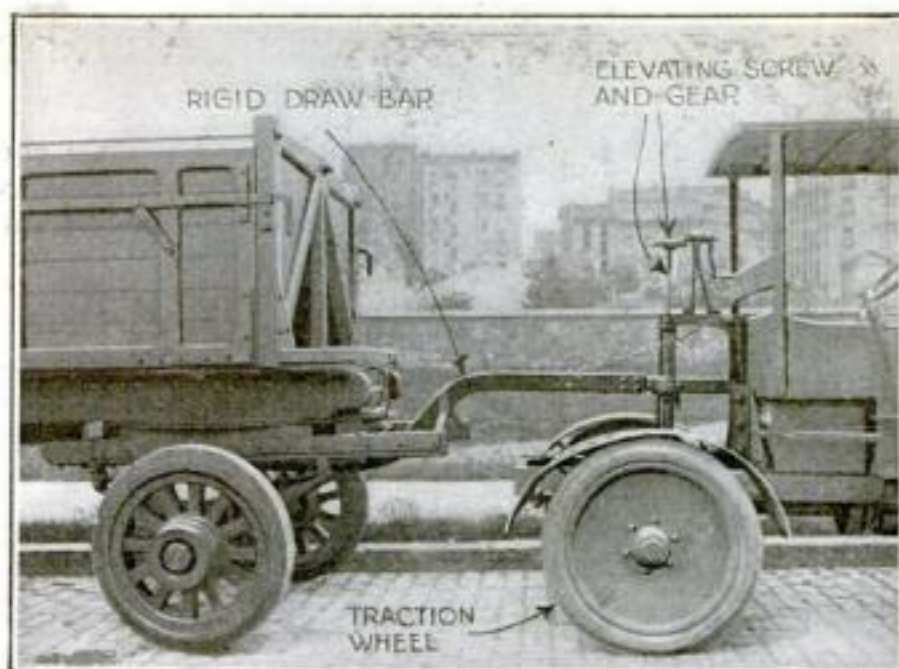
NO more will Colonel Bogey be hindered and tripped up by the imprints of horses' hoofs on the golf links, nor will his long drives be found nestling snugly in the little hollow where stepped some heavy-weight horse while pulling the mower.

It is now the fashion for golf clubs to mow their links with motor cultivators. The cultivator shown in the illustration was built for regular farm work, but when they hitched the mower to the cultivator, and started across the course, it was seen at once that they had hit upon a method of mowing that far surpassed the horse mower, both in the saving of time and the quality of the job.

The cultivator requires only a few slight changes in the attachments to prepare it for raking the golf course and doing various odd jobs in parks or gardens.



This new champion of the golf links plays the course in half the usual time consumed by horse-drawn apparatus



The greater the trailer load, the greater the downward pressure applied to the tractor's rear wheels by this connection

New Tractor-Trailer Connection

A NEW type of connection between a motor tractor and a four-wheeled trailer is designed to vary the pressure on the rear tractor wheels so that, no matter what the load carried in the trailer, the tractor rear wheels will always have sufficient traction to start the load.

A varying proportion of the weight of the load is exerted on the tractor platform by attaching the front end of the rigid trailer drawbar to an eye on the rear deck or platform of the tractor. This eye may be raised or lowered by a worm-and-screw device operated from the driver's seat. Thus a greater or less pressure may be exerted.

Getting Rid of Grease on the Automobile

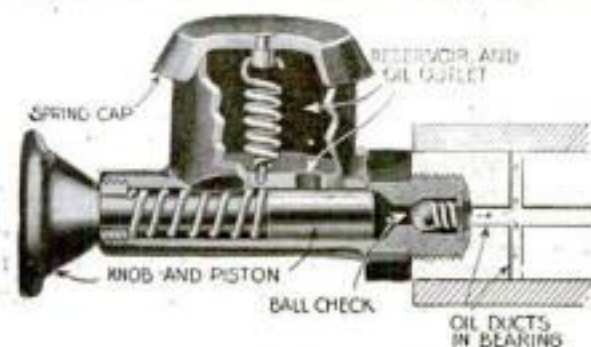
SLOWLY but surely the automobile engineers are getting rid of grease-cups and replacing them with oil lubricators. Grease-cups have never been entirely satisfactory because the caps rattle off under vibration, as when the car is going over a rough road, and because grease does not lubricate when it hardens. Oil, on the other hand, lubricates more readily because of its greater fluidity. Until now, the problem has been how to build an oil-cup that would not rattle off or permit the oil to leak out while the car was standing still.

The latest type of oil-cup is made in two forms, one with a vertical barrel for such parts as the steering knuckle and drag-link, and the other with a horizontally placed barrel for such parts as the front and rear spring bolts and shackle bolts. The vertical barrel type is thus used at four places on a car, two alike on either side, and the

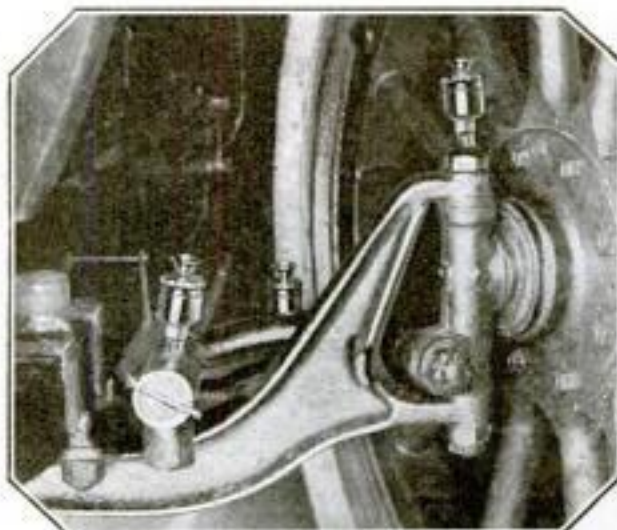
horizontal type at twelve places, six alike on each side of the car.

Both types are designed on the same principle and include an oil reservoir emptying into a small cylinder. This cylinder is fitted with a piston which normally is kept at the bottom by means of a spring around the piston-rod, which extends out through the top of the oil reservoir in the case of the vertical type of cup and out of one end of the cylinder in the horizontal type. At the bottom of the cylinder in each case, on that end nearest the bearing to be lubricated, is a ball check valve like that shown below in cross-section.

A knob is provided on the end of the piston-rod, outside of the cylinder.



The cross-section shows clearly the extreme simplicity of the oil-cup



The cup will not rattle off or allow the oil to leak while car is standing

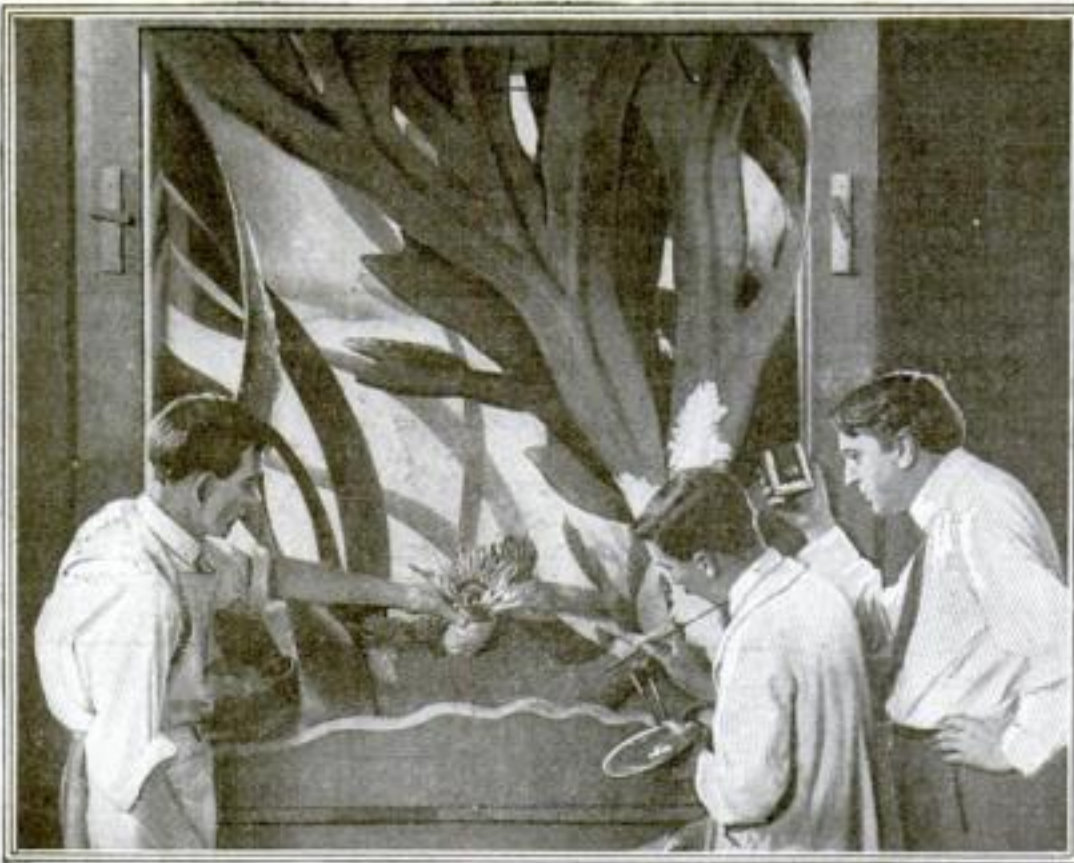


A pull on the knob of each oil-cup oils the car

When this knob is pulled, it moves the piston to the top of its cylinder, uncovering a hole leading from the oil reservoir and permitting the oil to fill the cylinder. Then, as the knob is released, the piston moves back by reason of the coil spring around the piston-rod, pushes the ball check valve off its seat, and forces the oil into the bearing.

With a car equipped with these oil-cups, it is necessary simply to walk around it and pull out each oil-cup knob once or twice and let it snap back in place. Each cup holds enough oil for from two weeks to a month, depending upon the use of the car.

By keeping the oil in a separate compartment, it is only fed to the bearing each time the knob is pulled out and snapped back.



The seaweed is made of wax, the shell-fish of wax with glass tentacles, and the section of scallop shell on which it rests, of plaster of Paris. The whole is a realistic picture of life at the bottom of the sea

To make glass work as fine as lace, all you need is a blowpipe and a pair of skilful—very skilful—hands



Reproducing Nature in Wax and Glass and Plaster

WHEN the American Museum of Natural History, in New York, decides to make a wax model of what the movies would call a "close-up" of the bottom of the sea, Mr. Roy W. Miner, the Associate Curator of Invertebrates, assembles his staff of three experts and takes them to the place where the weeds and sea-creatures that he wishes to reproduce are to be seen in real life. Photographs are taken; Mr. Shimotori, the artist, makes drawings in color; and Mr. Chris E. Olsen makes a small clay model to scale right on the spot.

From his models Mr. Olsen makes plaster molds in which white beeswax is cast to make the required leaf or fish. When the modeling is finished Mr. Shimotori colors the various parts. He uses oil colors and applies them with ordinary artists' brushes and the air-brush. In the lower picture Mr. H. Mueller, with the working drawing in front of him, is making delicate glass spines for a wax sea-worm's head. His apparatus consists merely of a gas blowpipe and his skilful hands.

The under-water background has to give the impression of fading away into the distance, and the light has to be carefully adjusted accordingly.

This effect is obtained by making the background of five separate sheets of glass, one in front of another. Upon the first are painted seaweed and fish, slightly blurred at the edges. On the other sheets of glass are painted objects of greater and greater indefiniteness. Finally, the ground-glass window behind the model is colored the greenish tint that water gives, and behind it a series of prisms is arranged to diffuse the light.

A New Way to Test Metals

IRON, steel, and other metals employed for technical purposes are now carefully tested for their surface hardness and their power of resisting various stresses to which they may become subjected while in use. For making these tests the apparatus shown in the picture is used.

By a hydraulic pressure as high as seven thousand pounds to the square inch a small and highly polished ball of extremely hard steel is pressed against the surface of the metal to be tested. The depth of the impression made in the surface of the metal is measured by delicate instruments and the relative hardness of the metal is determined by comparison with a predetermined scale.

The same apparatus and the same method, called the Brinell test after its inventor, is also employed for stress tests of metals. After the steel ball has been pressed in the surface a cross-section of the tested metal is made which is etched with acid and then examined with the microscope which discloses all structural changes produced in the metal by the pressure of the ball.



In testing the surface hardness of metals a hard steel ball is forced against the metal by hydraulic pressure. This man is watching the manometer indicating the pressure applied in the test

Soya Beans to the Rescue

THE praises of the Chinese soya bean as food have been sung by experts who wanted to bring down the cost of living. Industrious they gave exhibits of palatable ways in which it could be prepared. Still, for some reason, the soya bean as food didn't take—or hasn't yet!

But the soya is a versatile bean. Cast off as a food, it proves itself valuable as a paint and varnish oil! Its possibilities in this

direction were first investigated some time ago, when the failure of the flax crop in the Northwest caused a serious shortage of linseed oil. A large quantity of soya beans was imported from Manchuria and distributed pretty generally through the country with the cooperation of the United States Department of Agriculture.

The beans grew well in all sections, but thrived most lustily in the South. Here the cottonseed crushers took a keen interest in the experiment. Oil was crushed from the beans grown in this section and experiment established its desirability as a paint oil.

The Diamond and Its Bloody Story

All the revel, riot, recklessness, quick dramas, and dazzling riches of all the world's mining rushes and gold stampedes are crowded into the mad romance of the diamond

By Walter Noble Burns



ALL the diamonds in the world could be packed in your wife's clothes closet. They could be stored in a kitchen pantry, where, in the dim light, the cook might mistake them for navy beans and attempt a puree. They would form a pile about as big as the pile of coal the truckman dumps on the sidewalk at the basement entrance to your apartment building. If the pile had a base diameter of eight feet and were rounded into a cone, it would be five feet high. A pile of coal of equal size—and coal by every tie of chemical relationship is the diamond's first cousin—would cost \$28. The pile of diamonds, reckoned at \$100 a carat, would have a value of \$4,635,547,480. If figured at current diamond prices, it would be worth from three to five times that much.

There are, it is estimated, 46,355,474 carats of cut and polished diamonds in existence. In terms of avoirdupois they would weigh 10½ tons. The total includes possibly the first diamond ever found on earth—who knows?—and the last gem picked from the chimneys of South Africa; the little twinkler that the shop girl wears on her finger and the Kuh-i-Nur that blazes in Great Britain's crown.

The War Advanced Diamond Prices

One hundred dollars a carat, used as a basis in the estimate, is perhaps below the average cost of diamonds throughout history. Diamond prices have been subject to wide variations. The war advanced the price about one third. Present prices are about one hundred per cent. higher than those of fifty years ago, and they undoubtedly will go higher in the next few years. But every dia-

mond is an individual problem as far as price is concerned. The price always depends on the stone's color, comparative flawlessness, inherent brilliancy, and cutting.

A one-eighth carat diamond sells at present for from \$12.50 to \$20; one-fourth carat from \$37.50 to \$62.50; one-half carat from \$100 to \$200; three-fourths carat from \$187.50 to \$337.50; one carat from \$300 to \$500. Importers buy rough diamonds in foreign markets for about \$90 a carat. A rough crystal of 2½ carats, which will cut to a gem of one carat, costs \$225. Import duty is 10 per cent.; 1 per cent. is to be added for insurance and brokerage charges; the labor of cutting may be figured at \$15. The polished one-carat gem thus represents an outlay of about \$250. If this diamond turns out to be a gem of first

quality, it will retail at from \$500 to \$550.

But such quotations are not wholly dependable. Some blue-white one-carat stones sell for \$2,500, while you can buy a one-carat yellow diamond for \$150. Blue-white diamonds bring the highest price in the market. But many connoisseurs prefer as more beautiful the snow-white gem often found among river diamonds, whose sharp, cold brilliancy is like that of clear ice gleaming in winter sunshine.

Democratic Uncle Sam and His Diamonds

The United States in recent years has become the greatest diamond-buying nation on the globe. For years it absorbed from fifty to sixty per cent., and during the war 85 per cent. of the output of the South African mines, which supply 98 per cent. of all the diamonds in the world's markets. A recent estimate placed the value of the diamonds in this country today at \$1,350,000,000. Of this \$500,000,000 was set as the value of the stones in the country in 1900. Importations since 1900 have amounted to \$506,000,000, this including



The diamond was a clumsy jewel of dull luster until the art of cutting and polishing it was discovered in the fifteenth century. If the stone is large the first step is to make an incision and then to cleave it with a mallet, which two steps are illustrated by this picture

Some of the Diamonds that Have Had a Thrilling Past



A

B

C

D

E

The Regent, or Pitt (A), weighed 410 carats, and was bought for about \$120,000 by Pitt, Governor of Madras. The Duke of Orleans, Regent of France, paid \$400,000 for it. It was cut to nearly 137 carats, and was stolen during the Revolution, but was recovered and is still in France. The Kuh-i-Nur (B) led one Indian potentate to kill his three brothers and imprison his father. It has been cut and recut. It weighs now 125 carats and has been valued rather fancifully at \$1,000,000. The

Pigott (C) weighed 82 carats. It was last heard of in Egypt. It is valued at \$150,000, rather little for a stone of such size. The Empress Eugénie (D) weighs 51 carats, and is the property of the famous Gaikwar of Baroda. Two centuries before it shone on the bosom of the proud Eugénie it was given by a peasant to a blacksmith for mending a plow. The Duke of Westminster owns the Kassak (E), weighing something under 79 carats. Little is known about it

\$175,000,000 worth of rough stones which were doubled in value by cutting.

Prosperity has no better barometer than the diamond trade, and the increase in diamond buying year by year has reflected the nation's growing wealth. Yearly importations of cut diamonds increased from \$1,317,420 in 1867 to \$27,000,000 in 1913. They fell to \$18,000,000 the first year of the war, and to \$9,000,000 in 1915. They showed a reaction from war conditions in 1916, when they reached \$20,567,222, and were \$21,855,735 in 1917 and \$13,925,772 in the first eight months of 1918. The diamond-cutting industry in the United States began in 1873, when \$176,426 worth of rough stones were imported. Importations amounted to more than half the importations of cut stones in 1916 and 1917, and had become almost equal in 1918.

Time was when they adorned only the princes of the earth and sparkled only in palaces. But they have become a democratic gem in the great democracy of the West. The stenographer emits Kimberley sparkles. Faint Dutoitspan gleams show in the ears of the pretty waitress. No cook or housemaid can hold up her head without a diamond among her jewels.

Diamond Cutting—a Distinctly Modern Art

The perfectly cut and brilliant diamond the world knows today is not more than fifty years old. The ancient world knew little of diamonds. From the first pharaoh to the last, through all the pageantry of thirty-one dynasties, diamonds were unknown in Egypt. From the dawn of history, Babylon remained unfamiliar with them for forty centuries. The pioneering conquest of Alexander across the Indus in

327 B.C. acquainted Greece vaguely with their existence. The patricians of Rome in the days of the early empire rarely owned them. Byzantine supremacy, the rise of Venice to maritime power, the Moorish conquest of Spain, brought only a trickle of diamonds into western Europe. A fashionable jewelry store in America today carries more diamonds in stock than were in all Europe when Columbus sailed from Palos.



© Topical

The Cullinan diamond was divided into nine large stones and a number of small brilliants. Here is the biggest of the stones. It weighs 516½ carats and is the largest brilliant in the world.

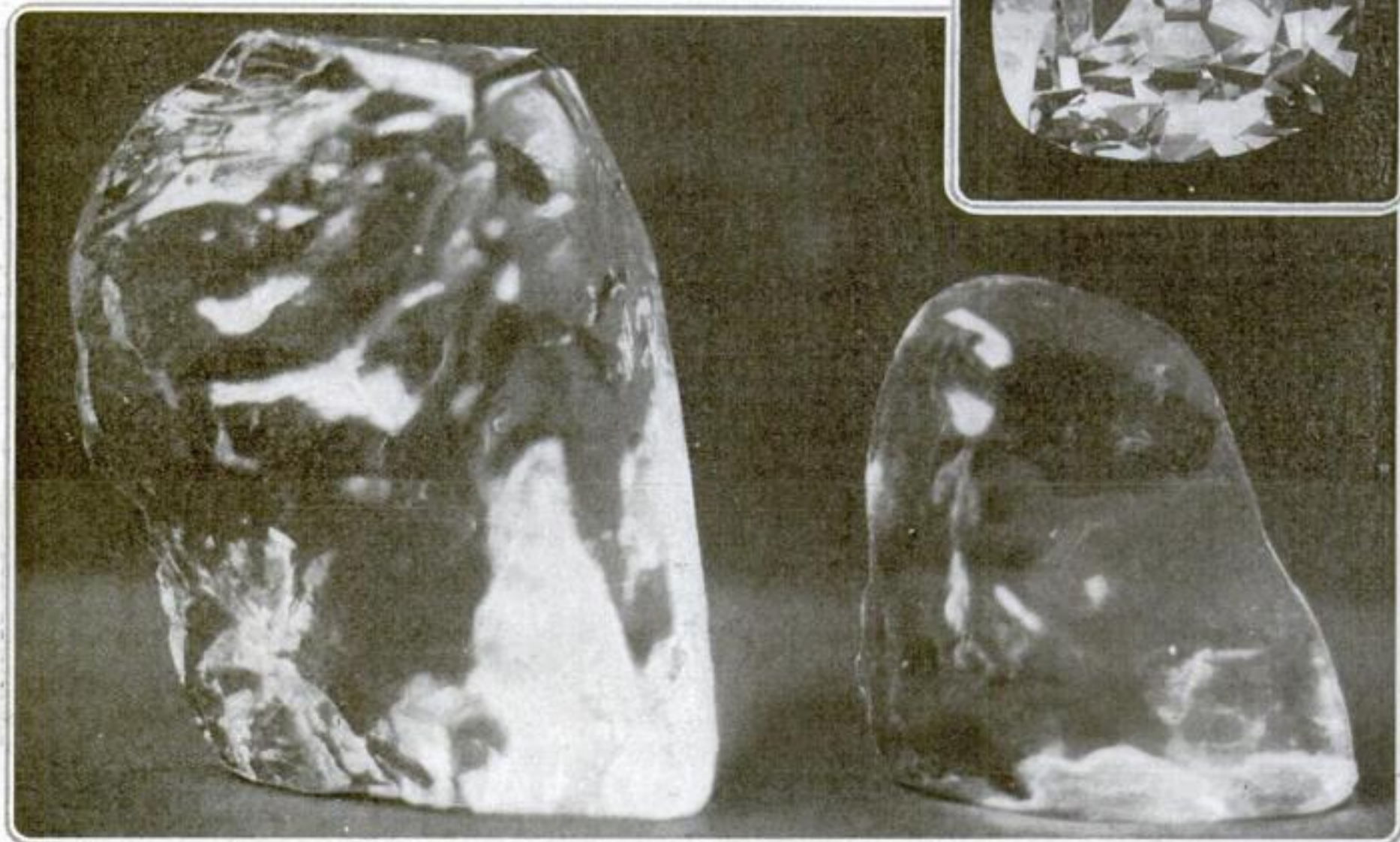
To the right is a brilliant weighing more than 309 carats. It is the second largest stone cut from the famous Cullinan

The earliest cutters used their wheels deftly enough, but they neglected their mathematics. Bringing out a diamond's full brilliancy is a mathematical problem. Increase of facets adds to surface area and surface glitter. But the angle of total reflection must be considered in relation to the angle of incidence, and the facets so arranged that a ray of entering light will be reflected from the inner facet surfaces and returned in refracted rainbow sparkles through the top of the stone.

Making the Diamond Sparkle—a Mathematical Problem

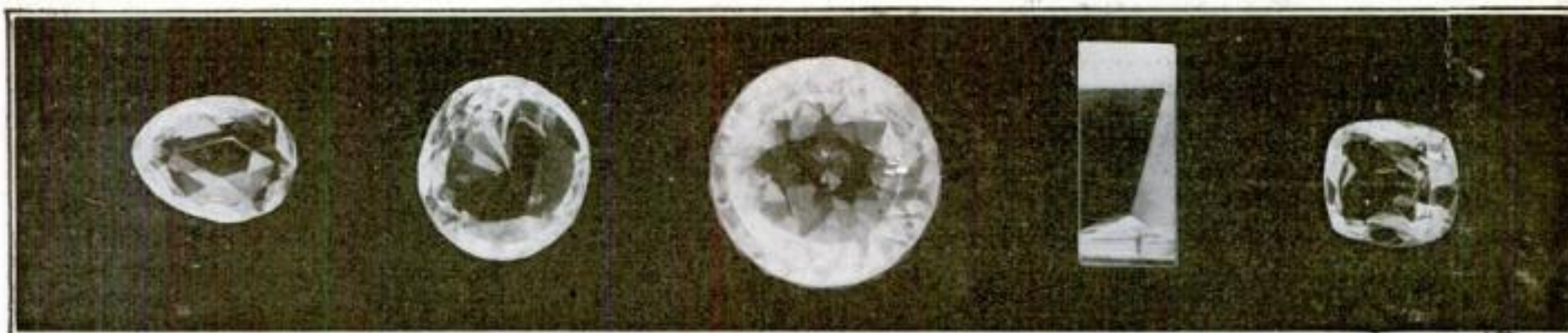
Henry D. Morse, of Boston, in the last century was the first to discover the balanced proportions that developed a diamond's highest reflective and refractive possibilities. Since brilliancy is the crowning glory of a diamond, he did not hesitate to sacrifice whatever weight was necessary to achieve it. Retaining the fifty-eight facets of the earlier cutters, he found that a diamond is at its sharpest climax of brilliancy when its depth from table to culet is six tenths of its diameter, and a little more than two thirds below. Cut in this style, a diamond not only flashes light from every polished facet surface, but seems alive with coruscating inner fires.

Morse's proportions are the rule of the world today, and they mark the final



To the left is the Cullinan diamond as it appeared in the rough. It weighed in this state 3,025¼ carats (1½ pounds) and was as white as water. The stone was purchased from the Transvaal Government in 1907 and presented to King Edward VII

To the right is the Excelsior diamond, found in 1893 at the Jagersfontein by a native while loading a truck. It weighed 971 carats in this rough state, and was ultimately cut into ten stones weighing from 68 to 13 carats



A B C D E

Swallowed by a faithful serving-man to save it from the robber who slew him, the Sancy (A) was sliced from his stomach to adorn the royal person of Henry of France and Navarre. The Orloff (B) was stolen by a French soldier from the eye of an idol in a Brahmin temple, stolen again from him by a ship's captain, bought by Prince Orloff for \$450,000, and given to the Empress Catherine II. It weighs nearly 105 carats, and was one of the Russian crown jewels. The great Mogul (C), most magnificent of Indian gems, disappeared from

history, never definitely to reappear. It has a bloody history going back to the year 1665. Its fame lured Nadir Shah to the sack of Delhi. This is a glass reproduction made from extant descriptions. It probably weighed after cutting, 280 carats. The Akbar Shah (D) was originally a stone of 116 carats with Arabic inscriptions upon it. After being cut down to 71 carats it was bought by the Gaikwar of Baroda for \$150,000. The Polar Star (E), a magnificent stone weighing 40 carats, belongs to the Princess Youssouppoff

triumph of art in the achievement of the perfect modern jewel.

Fiction in its maddest moods never invented romance more bewildering than the stories of the great diamonds of India. For these baubles wars have been waged, nations devastated, thrones and dynasties overturned, men slaughtered by tens of thousands. For gems men have plotted, intrigued, robbed, murdered, committed every cruelty and treachery, stained their souls with every crime.

The fame of the Great Mogul lured Nadir Shah to the sack of Delhi. Desire to possess the Kuh-i-Nur was woven into the complex motives that led Aurung-zeb to deluge India with blood, slay his three brothers, and dethrone and imprison Shah Jehan, his father.

The Orloff, stolen from the eye of a temple idol and sold overseas, was presented to Catherine of Russia by her princely paramour to patch a lovers' quarrel. Swallowed by a faithful serving man to save it from robbers who slew him, the Sancy was sliced from his stomach to adorn the royal person of Henry of France and Navarre.

The Great Mogul, the most magnificent gem of the Indian mines, disappeared from history, never definitely to reappear, its fate a riddle of the centuries.

The Baleful Gleam of the Hope Diamond

The Hope blue diamond—stone of tragic fame—is the only one of the great historic diamonds to come to the United States. When Louis XIV bought it in the seventeenth century, it was a gem of 67½ carats. It disappeared during the French Revolution, and remained lost until 1830, when it reappeared as a jewel of 44¼ carats.



© Harris & Ewing

The ill-starred Hope diamond eventually passed into the possession of Mrs. Edward Beale McLean, whose husband bought it for \$300,000. She wore it on one occasion together with the Star of Este, the two stones together being worth \$500,000. The occasion was a dinner which, a curious statistician figured, cost about \$166 a minute

From its first appearance in Europe, a superstition has clung to it that it brought disaster to all whoever owned or wore it. Certainly it has been associated with a long list of tragedies. Tavernier, who brought it from India, failed in business, and died on his voyage back to the Orient to recoup his fortune. Madame de Monte-

span, upon whom the Grand Monarque bestowed it, was supplanted in the king's affections by her rival, Madame de Maintenon. Nicholas Foquet, a courtier who borrowed it, was executed. Louis XVI and Marie Antoinette, who inherited it, lost their heads on the guillotine. Princess de Lamballe, of Marie Antoinette's entourage, was killed by a revolutionary mob.

The thieves who stole it were executed or deported to penal colonies. Wilhelm Fals, the gemsmith who cut it down for them, ended his life in poverty. Hendrik Fals, his son, who stole it from the thieves, committed suicide. Francis Beaulieu, last of its underworld owners, who sold it to Daniel Eliason, a London jeweler, died of starvation in a garret in Soho. Lord Francis Hope became a bankrupt, and was scandalized by the elopement of May Yohe, his American actress wife. At last accounts May Yohe was a scrubwoman in Tacoma.

Lorens Ladue was shot and killed by her infatuated admirer as she danced in the glare of the footlights with the diamond on her bosom. Her Russian cavalier, who had hung the jewel about her neck, was assassinated. Simon Montherides, who sold it to Sultan Abdul Hamid, was killed in an accident. Two of its Turkish custodians were murdered. Salma Subaya, the sultan's favorite, was shot while in the Yildiz Kiosk; and Abdul Hamid finally lost his throne.

Imported into the United States, it was bought by Edward B. McLean for \$300,000. As beautiful as when, fresh from the mystic East, it dazzled the court of France, the diamond for years brought only happiness to its new owners. Then one day the little son of the McLeans, first-born of a happy marriage and heir to vast riches, was killed at play by an automobile. Instantly the tragic tradition recurred to the public.



A B C D E

The Florentine diamond (A), among the crown jewels of Austria, weighs 139½ carats and is valued at \$525,000. It is a very pale yellow. It was picked up on a medieval battlefield and sold for two francs. The Hope (B), 44¼ carats, is believed to be a portion of a beautiful blue stone of 67 carats cut from a stone weighing over 112 carats, which was discovered in India, brought to Europe by Tavernier, and which was stolen from the French crown jewels. The Hope has

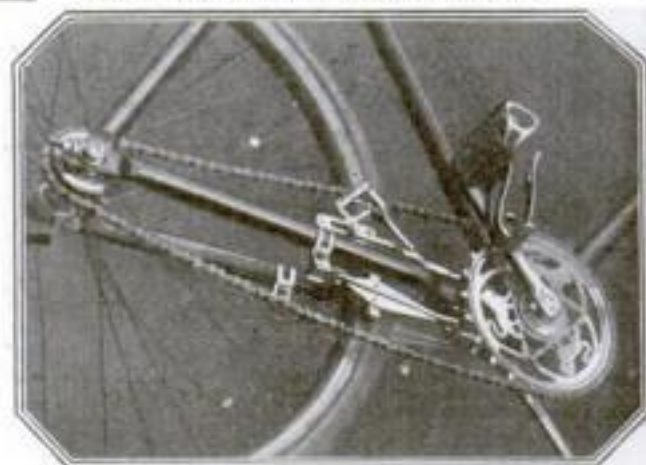
the same color as the missing gem. The Kuh-i-Nur (C) eventually passed into the hands of the East India Company, and was presented by it to Queen Victoria in 1850. This is a picture of it recut to 106 carats. The Star of the South (D), perhaps the most famous of Brazilian stones, was found in 1853. It was cut from 254½ carats to 125 carats, and was bought by the Gaikwar of Baroda for \$400,000. The Pasha of Egypt (E) weighs forty carats and is valued at \$140,000

The Bicycle Gets Its Emergency Brake

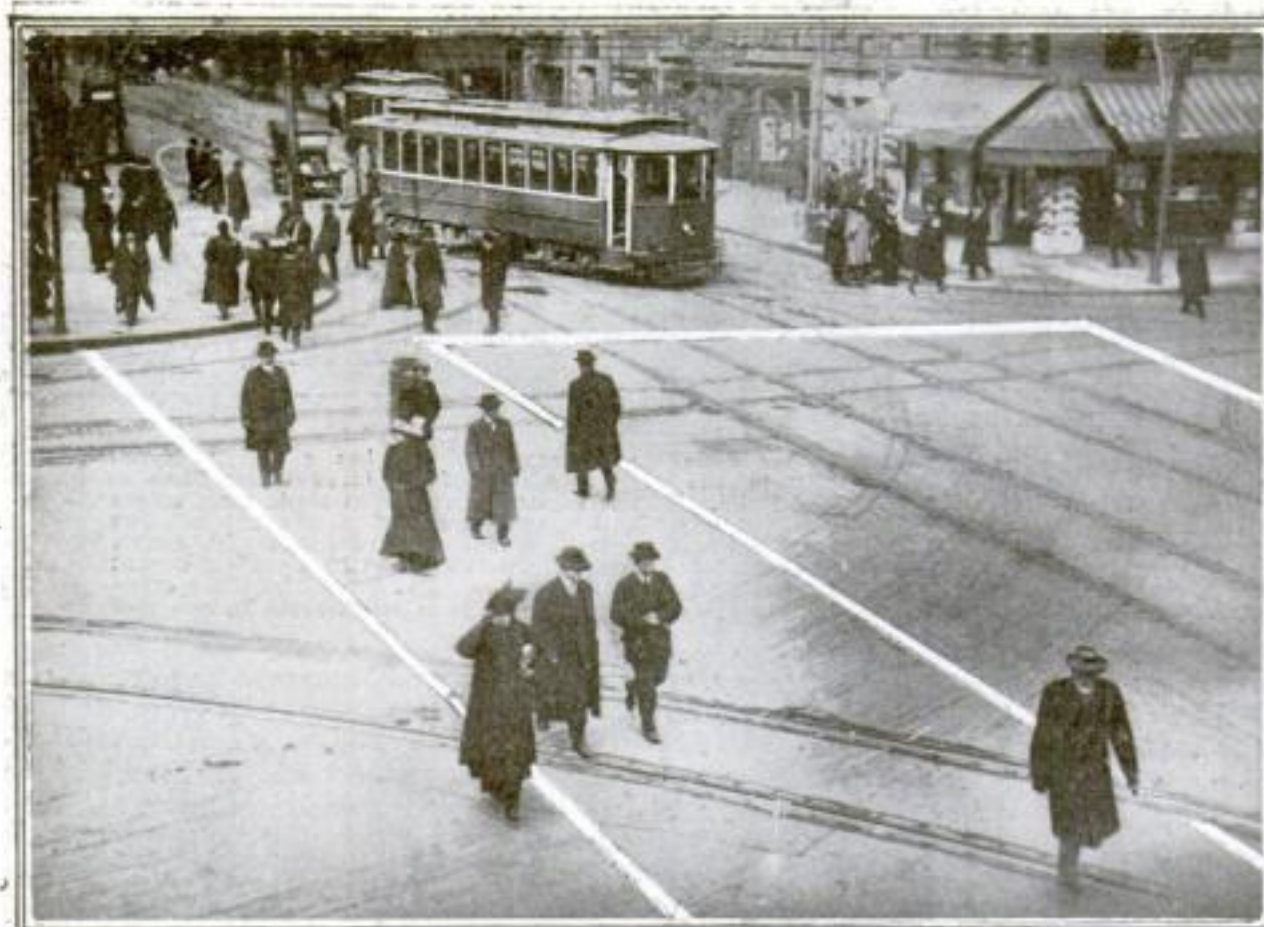
SNAP! The brake-band broke and the cyclist shot down the hill at a speed that increased with every second. If his wheel had been equipped with an emergency brake there would have been no danger.

Such a brake was recently invented by a Frenchman. To work it you simply back-pedal. Forward-pedaling keeps the chain tight, while back-pedaling slackens it. The emergency brake has a tooth, which is stationed just below the tight chain. When the chain slackens, one of its links drops over a tooth and pulls it backward as the rider continues to back-pedal. This movement of the tooth affects levers that press on the sides of the rear wheel and act as a brake.

In the picture below you can plainly see the tooth and chain interlocked, while a small bar presses down on the rim of the wheel.



This bicycle has an emergency brake which is worked simply by back-pedaling



© Press Illustrating Service

Between these lines lies safety. This is Cincinnati's idea of first aid to preoccupied pedestrians. It's a woman who is ignoring the rule and cutting across the corner

How They Cross the Street in Cincinnati

LINES and feet seem to be indivisibly connected. We have been enjoined, ever since we can remember, to "toe the line." More recently, New Yorkers have been ordered to "follow the black line" and "follow the green line" when adventuring in the subway.

Cincinnati works along still other lines. The city fathers have had lanes marked out by two white lines at

the busy crossings, with the legend on the curb-stone, "Walk between the lines." Vehicles do not cross the safety-zone until they are signaled to do so by the traffic policeman.

At present the white marks are painted on the pavement, but they are to be made permanent with white bricks.

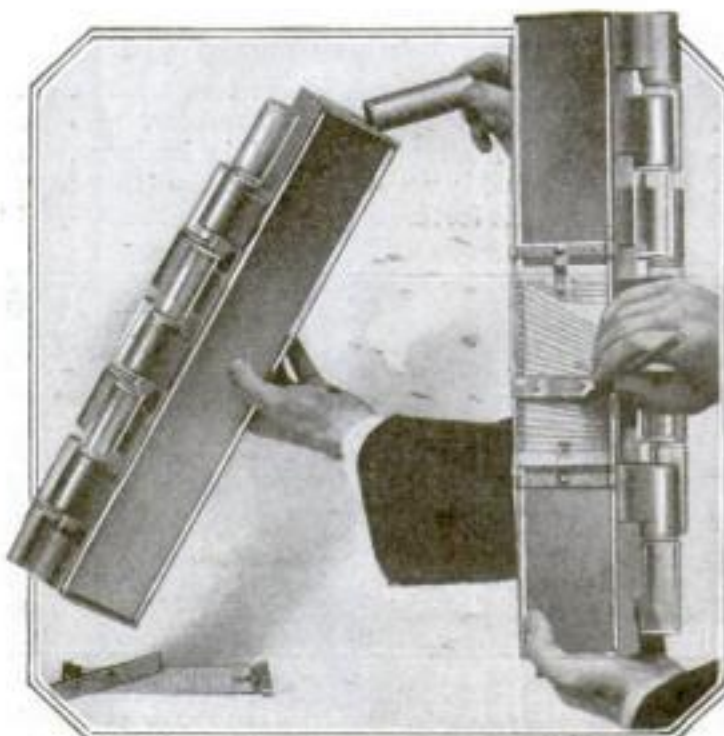
This Apparatus Tests Sand on the Job

A SIMPLE apparatus recently invented makes it possible to test the sand to be used in concrete work without sending samples to the testing laboratory. It consists of a rectangular metal box with an opening at one end. By five screens graded as to mesh and soldered to the sides of the box the receptacle is divided into compartments, each communicating by soldered elbows with small glass vials placed in two rows on the outside of the box.

In making the test a measured sample of the sand is poured into the box and shaken through the screens. Then water is added, the opening closed, and by a gentle swaying motion the sand on the five screens is washed into the corresponding vials.

The sand is allowed to settle before the record is taken. The record sheet is fastened to a sliding pad, and on it cross lines are drawn indicating the levels of the sand in the five vials. These lines intersect the index line at certain

points and the slanting lines of the percentage scales indicate how large a percentage of the sand passed or was retained by each screen.



Sand is poured into the testing apparatus, shaken into glass tubes through graded screens, and the result recorded on a specially ruled sheet

When It's Clean-Up Day in Poland

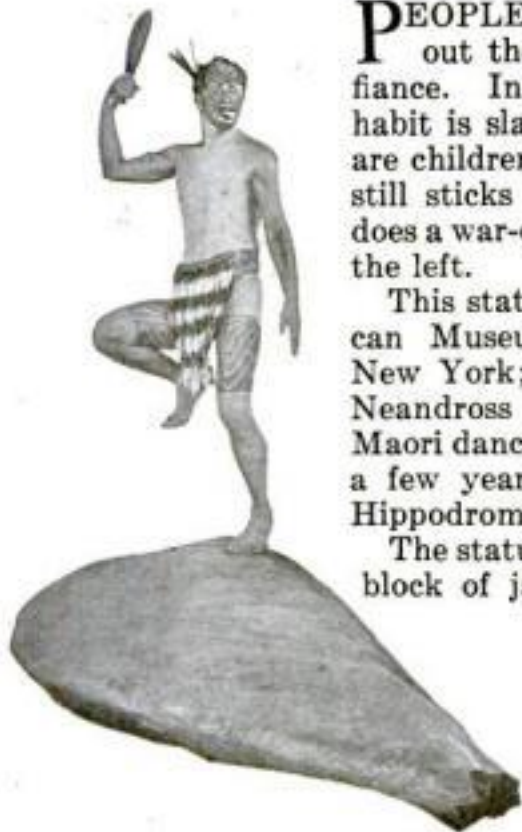
"ALL men, boys, and young girls must have their heads shaved completely on April first." Suppose our government issued this order, how would you like it? Poland has issued this order.

Ever since war broke out in 1914, Poland has suffered severely from typhus. The hair-cutting order is simply part of an extensive campaign for wiping out the disease. On the same day that their hair is cut, the victims must also take a bath.

The campaign will last for three months and each village is assigned a clean-up day. The people are also supposed to disinfect all bedding and clothing on that day. Health authorities point out that if typhus is not stemmed in Poland it will soon spread to all western Europe.

Poland will need for her general clean-up one hundred physicians, one thousand steam disinfecting machines, eight hundred thousand pounds of cresol, and three hundred tons of soap.

A War-Dance on a Block of Jade



The largest block of green jade known to exist has mounted on it the statue of a Maori warrior

PEOPLE the world over stick out their tongues to denote defiance. In civilized countries this habit is slapped out of us when we are children, but the Maori warrior still sticks his tongue out when he does a war-dance—note the statue at the left.

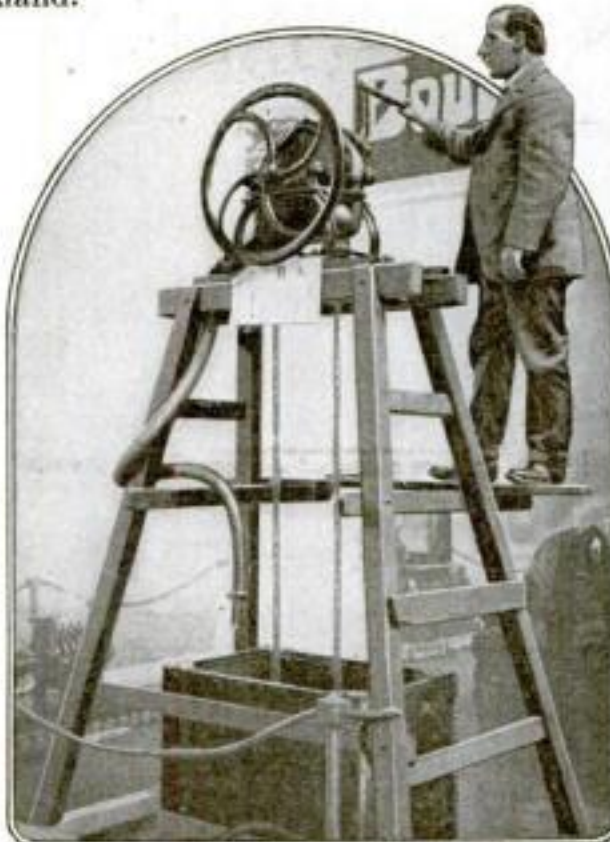
This statue is found in the American Museum of Natural History, New York; it was made by Sigurd Neandross and was posed for by a Maori dancer brought to this country a few years ago to dance in the Hippodrome.

The statue is poised on the largest block of jade known to exist. It weighs three tons, and is seven feet long and four feet wide. Both the dancer and the jade came from New Zealand.

This Pump Is Called a "Mechanical Impertinence"

WHEN an eminent British scientist saw this pump at the Dairy Show in London, he was so astonished by its simplicity that he laughingly called it a "mechanical impertinence."

The water is drawn up by an endless chain enclosed in close spiral coils. The chain is weighted at the immersed end by a grooved wheel. At the upper end the chain rests in the groove of another wheel, which may be rotated by hand or by motor. As the chain is drawn through the water the liquid fills the space between the links and the coils of the spiral and is held there by capillary attraction until it is released by centrifugal force as it is whirled around the driving wheel at the top. The length can be adjusted.



© Keystone View Co.

It pulls up water by an endless chain surrounded by a spiral coil which holds the liquid by capillary attraction



This decoration in front of the window is a willow root that grew within a water-pipe and gradually cut off the water supply

Watch Out for Willow Roots

HANGING up in front of the Water Department of the village offices at Lakeville, N. Y., there is a twenty-four foot willow root. And the Water Department keeps a careful eye on it, for it is a trouble-maker—last year it very nearly cut off the city's water supply.

Here's how it happened. Twenty years ago a wooden plug was driven into the pipe and a small tendril from the root of a willow tree near by got mixed up with it. This tiny root grew rapidly within the pipe and gradually choked off the flow of water.

The Water Department naturally thought there must be a leak somewhere. Three men were sent out to find it: instead they found twenty-four feet of willow root clogging the pipe.

To remove it a section was cut from the pipe and a strong rope fastened around the head of the root. It took three men to pull it out. The root is now supported by three hooks on the window of the village offices, and the admiring natives visit it regularly.

Grow Your Own Molasses

WHEN food was scarce here because of Europe's need, people grew food in their back yards. Now that sugar is scarce, why not grow sugar-cane there? Mr. Oscar C. Duffy, of Springfield, Ohio, tried it, and now he has twelve gallons of sorghum molasses in his cellar.

It was not the sugar-cane of the sunny South that Mr. Duffy grew, but Chinese sugar-cane or sorghum, which is hardier than sugar-cane and comes to maturity in one season. It is a cereal and the sugar is in the stem.

When the sorghum was full grown, Mr. Duffy found that there was no mill near by to which he could take it. What did he do? He built his own mill, which he operated with the help of his sons. He made the mill out of two wash-tubs, a clothes-wringer, two four-inch rollers, and several planks.

He crushed the stalks between the rollers and the juice and pulp fell into one tub. Next he ran the pulp through the clothes-wringer and extracted more juice. He boiled the juice in a wash-boiler and molasses was the result.



Oscar Duffy, aided by his two sons, is making molasses in a homemade mill out of sorghum grown in his own back yard

These Are the Real Money-Makers

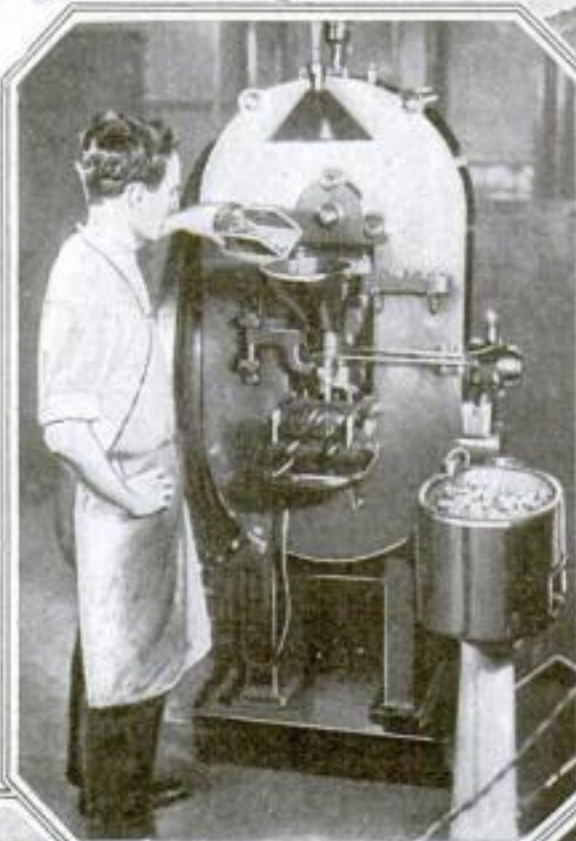
They are turning out pennies galore so that we'll all have enough to pay our war taxes

Photographs © International Film Service



Sixty million pennies are turned out in one month and a great many of them pass through this tray on their way to the stamping-machine; the white-haired lady inspects the disks and picks out those that are imperfect

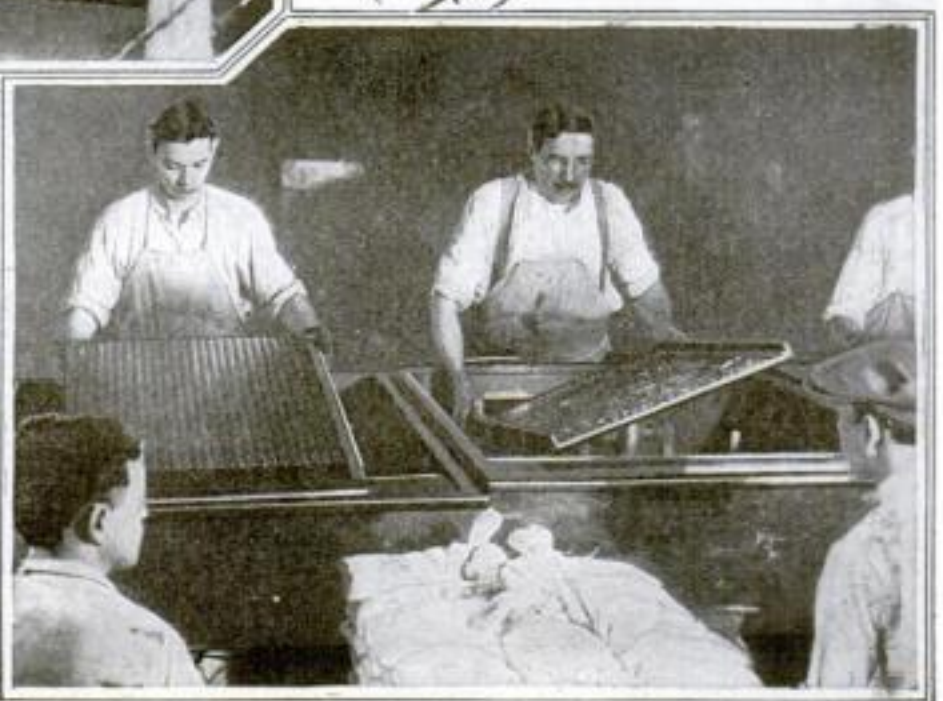
Pouring the disks in the stamping-machine, where they are molded into final shape



The long strip of copper being fed to a punching-machine in which disks are punched out at the rate of one hundred and fifty a minute



The finished coins scooped into scales and weighed in large quantities to determine the gross number turned out, the number of pennies to the pound being known. There are about seven hundred dollars' worth of pennies in the scale now

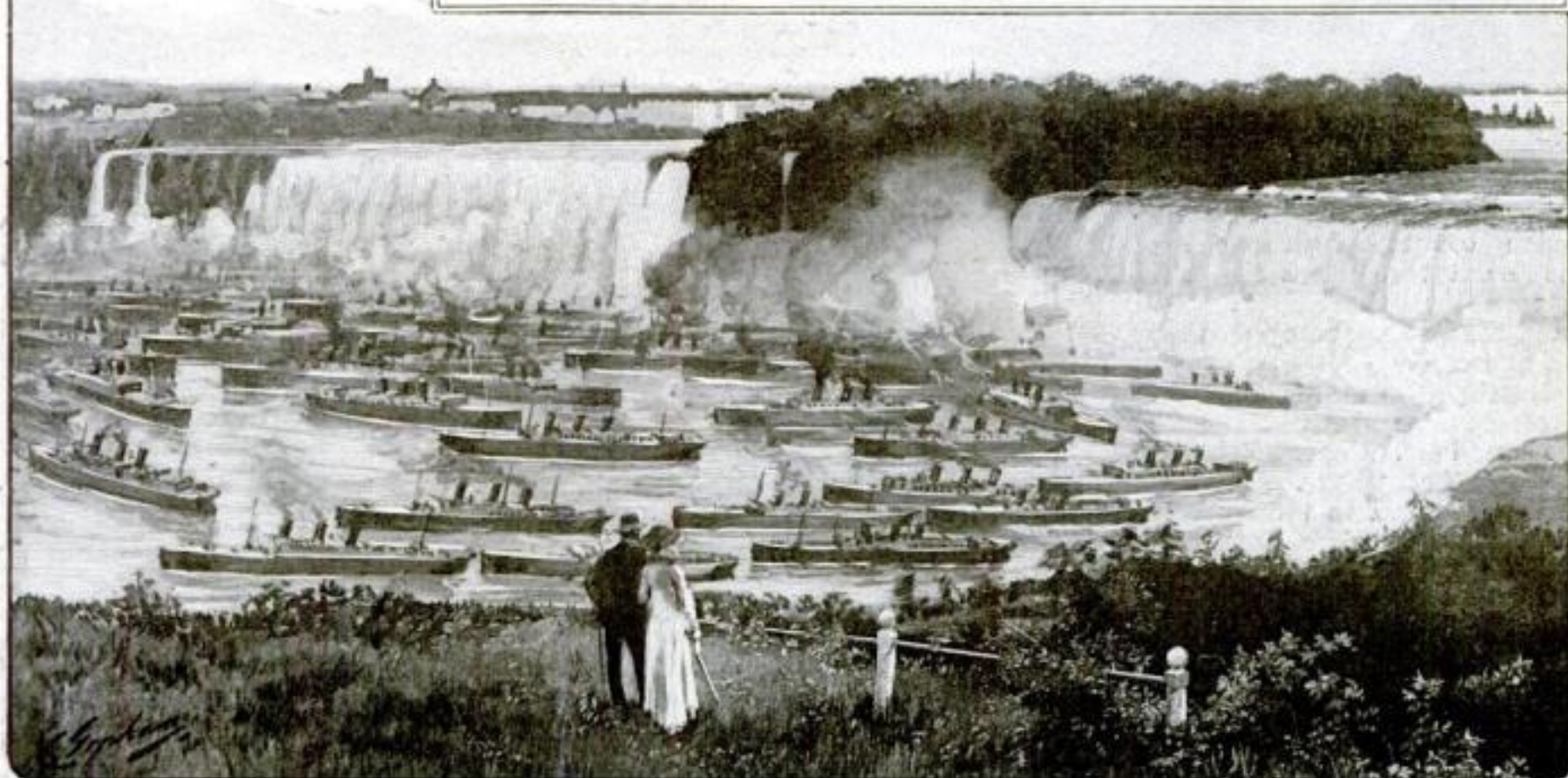


Each board holds one thousand pennies, a penny fitting into each slot; when all the slots are filled the pennies are dumped into a bag, ready for distribution. The Mint at Philadelphia runs night and day to supply the demand

Prohibitionists and "Antis" Take Notice

How much water is used for personal purposes by the American people? We mean for drinking, bathing, cooking, and washing. Statisticians say that the average family contains three members, and that each family uses an average of 90 gallons a day. Hence each member of a household uses 30 gallons a day. Now, the present population of continental United States is approximately 105,000,000. The total consumption of water for household and personal use amounts to the enormous total of 400,000,000 cubic feet daily. What has all this to do with Niagara Falls shown at the right with an enormous water faucet turned on full? Just this: the daily consumption of water in the United States is enough to keep a Niagara Falls going for the period of thirty-five minutes

A ship afloat displaces an amount of water equal to its own weight. Thus the *Leviathan*, with a tonnage of 50,000, displaces 1,600,000 cubic feet of water. It would take 250 such giant steamers to displace the quantity of water that the American public is said to consume every day



In Behalf of Window-Washers

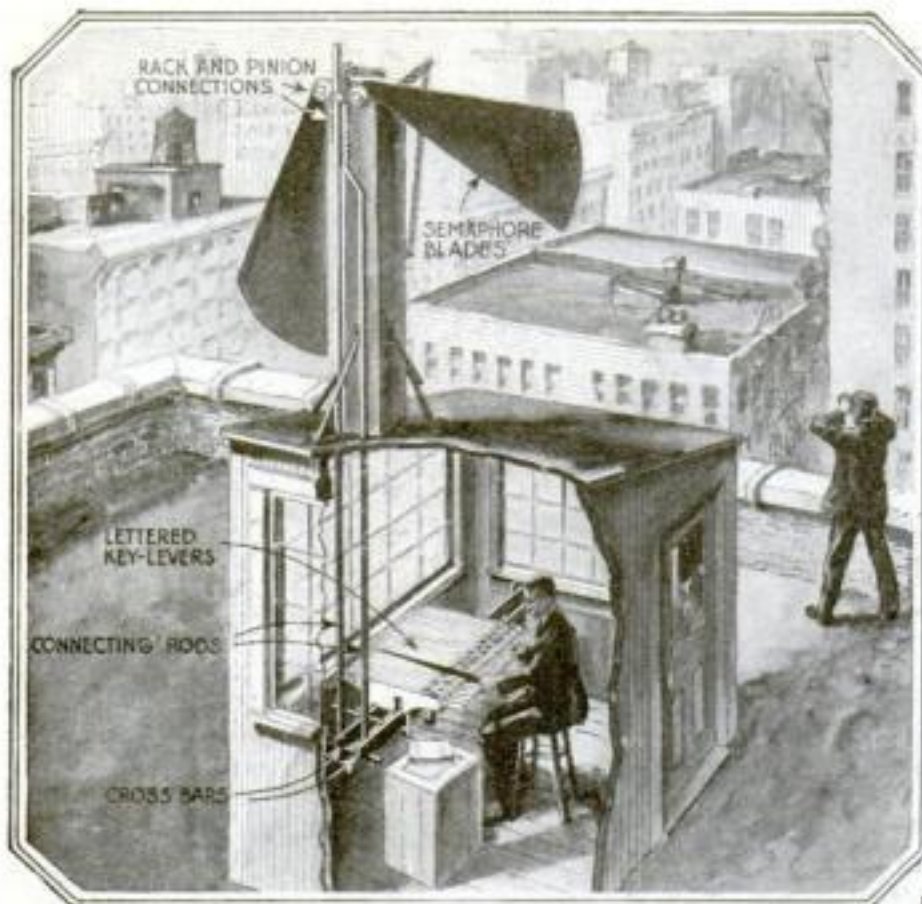
NO one likes to wash windows. If you sit or stand outside you run the risk of falling. If you work from the inside you must go through contortions in order to reach the center point on the outside of the lower window-pane. Is there no remedy for this?

Yes, says Alexander Kuneman, of Erie, Pa.; for he has invented "new and useful improvements in windows" distinctly for the purpose of facilitating window-washing. The lower sash is mounted so that it will swing, and the upper one may be lowered and fastened to it so that the two will swing together. When you wish to wash windows you swing the two sashes into the room and do your wash-

ing in comfort. When the upper sash has been polished, slide it back into place. The lower sash may then be swung in alone, and given its turn at the chamois.

It is a well-known fact that unionized window-washers make more money than most college professors. But window-washing is a dangerous job, particularly when the window in question is on the fortieth floor of a building.

When you wish to wash this window you simply swing it into the room



The operator of this mechanical semaphore spells out his messages by pressing down levers representing the letters of the alphabet

Signaling on a Keyboard

THE man in the little house on the roof is not ringing chimes, nor is he playing the calliope or setting switches in the railway yards; he is operating a semaphore of an improved pattern, spelling out the letters of a message to a distant observer.

The man who signals with flags or who uses one of the numerous mechanical signaling apparatuses heretofore tried, must go through a course of training before he can safely be entrusted with sending or receiving messages. With the apparatus shown in the picture anyone who is capable of reading can send messages.

Each lever represents one of the letters of the alphabet. The levers are arranged like the keys of a piano or a calliope, all being pivoted to the same stationary rod or bar fastened to the wall of the cabin. Each of the two blades of the semaphore is connected by a rod with one of the two parallel cross-bars shown in the picture. These cross-bars are pivoted at one end, while the other end has a rack-and-pinion connection with one of the semaphore arms in such manner that the arm is raised when the corresponding cross-bar is depressed.

On their lower edge the key levers have notches which engage the cross-bars. These notches are so gaged that, when the key lever is pressed down to the stop, the cross-bars will be depressed so as to bring the semaphore blades to the position representing the letter of that particular key. When the key lever is released, the semaphore arms are snapped back to their original position by powerful springs.



War on the Jack-Rabbits

JACK-RABBITS multiply so rapidly that their depredations on growing crops frequently become a real menace. In many parts of the Middle West active measures have to be taken to keep down the numbers.

A wire-and-slat corral is constructed

at some central point. From the entrance long wing-fences extend in a wide V. Every available man, woman, and child in the neighborhood is mustered to surround a large area and drive the rabbits toward the corral; the wing-fences steer them into the trap.



At the end of a perfect rabbit drive. These organized drives not only free the district of crop-destroyers, but provide a considerable source of food supply

She Carries Passengers Instead of Bombs

The new giant Zeppelin "Bodensee" can never be used in war

By Carl Dienstbach

WHEN recently the Hamburg-American Steamship line resumed its aerial passenger service, having built a new dirigible for the purpose, the agreeable fact became evident that this up-to-date Zeppelin was inherently a peace craft and could never be converted into a war craft. This new vessel, named the *Bodensee*, cannot navigate the air unless it carries its quota of passengers or an equivalent in ballast, which may neither be dropped nor consumed. This is due to a boldly novel distribution of weights.

In former ships the passenger cabin was located, like the observer's seat in an airplane, at the center of gravity, where, full or empty, it could never disturb the balance. On the new ship the cabin is at the front end, ideally located for comfort and aerodynamical considerations, but out of balance when the Zeppelin is empty.

Suppose bombs or additional fuel for sea cruises were loaded into that cabin. The bombs could not be dropped because in that case the elevators would be so taxed in forcing the nose down against its sudden lightening that they would become unfit for other use. Letting out gas in front only would be too slow a compensation. This trouble is radical and inherent, because it could be remedied only by an entire redistribution of the fixed weights behind, which in turn would demand reconstructing the hull.

But let us discuss the peace possibilities of this design. To combine the navigating cabin in front with the passenger cabin is ideal. It insures in the whole front part the cleanliness, splendid repose, unlimited view, purity of air, and absence of fire danger of a spherical "free balloon." Navigating instruments and wireless are doubled in efficiency, the officers' nerves are saved by the remoteness of the engines and the proximity of comfort and a "mess" and pantry. Air resistance is splendidly reduced by the well proportioned long, smooth structure of this united cabin—the absence of fire danger making it possible to place the cabin tightly against the hull, giving direct access to its "hold."

Attention should be called to the glazing over of all the

many windows necessitated by modern speed—in place of the "gaping holes" in the old cabins. The three engine-rooms are far behind, transmitting not a particle of vibration or noise, yet under instant control by telegraph and telephone.

The final and most telling plea of this craft for peace is in its size, preventing war altitudes. It is not at all a "super-Zeppelin," not even an old-fashioned naval Zeppelin. It accommo-

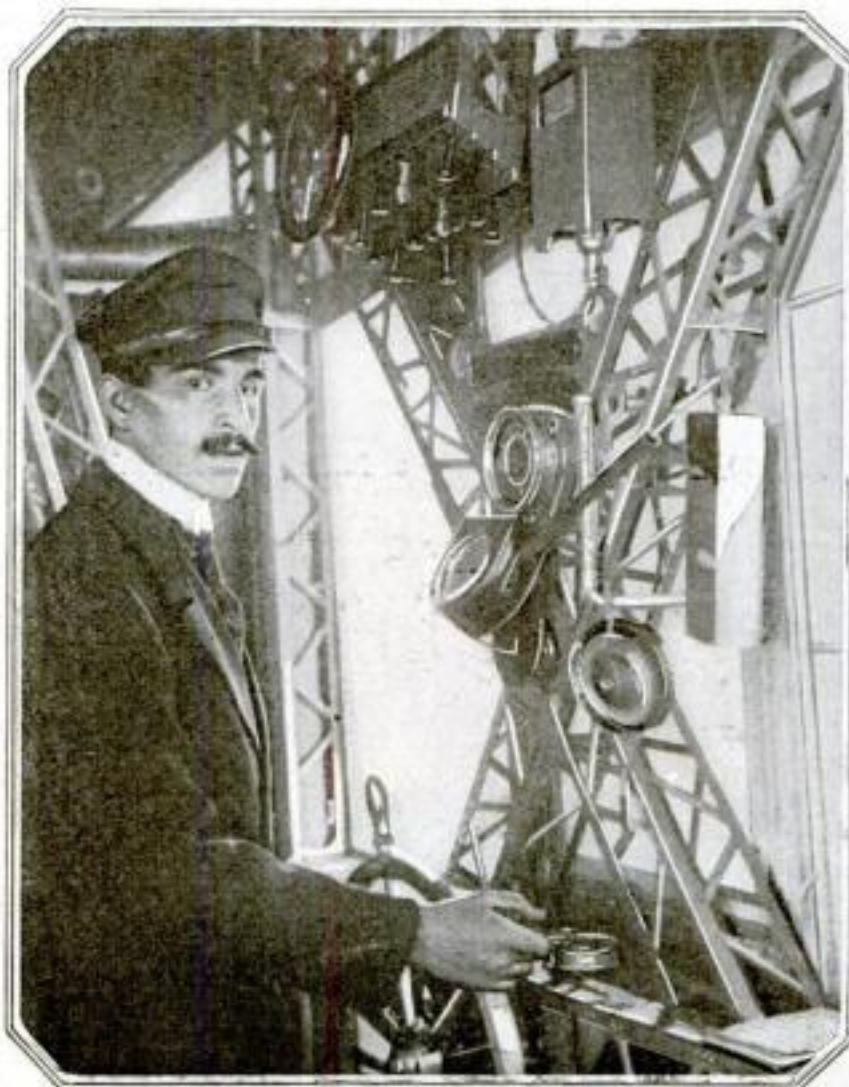
dates fifty passengers and will reach Berlin from Lake Constance (that is, crossing three fourths of the German territory) within four and a half hours. The train takes fourteen hours. Passenger Zeppelins now call for a revision of established ideas on travel. All Europe is as easily within their direct range as the nearest fifty miles are to the owner of a Ford.

The completeness of commercial success of the resurrected peace Zeppelins may best be gathered from a statement made by an American lawyer who recently returned from a business trip through central Europe. He said that he would have "taken the Zeppelin" from Munich to Berlin if the day in question had not been the day of the Berlin-Friedrichshafen trip. It costs but one hundred marks to ride on the *Bodensee*.

You may remember the recent account of the accident which befell the *Bodensee*. She was landing in a high wind when suddenly she broke away and disappeared in the night. Her front gondola was smashed and one of her engineers was killed. She landed safely the next day several miles away. The men who helped her try to land were really responsible for the accident; they were friends of the passengers and knew nothing of the skill necessary in order to land a Zeppelin safely. It is just as hard to dock an airship safely as it is to dock a ship.



The crew of the great passenger Zeppelin *Bodensee* is lined up alongside of the cabin; the *Bodensee* will accommodate fifty passengers



At the wheel you see the navigator in the *Bodensee*, a Zeppelin that makes regular passenger trips and belongs to the Hamburg-American Line



The Banjo of a Thousand Pieces

A BANJO made up of fourteen hundred and thirty-four pieces has traveled over sixty-four thousand miles in the last fifty years—and has never lost a piece.

The banjo with this record is studded with bits of pearl, ivory, and colored wood, in all shapes and sizes, and was made by its owner, Joe Patterson, of Eastport, Maine.

Joe Patterson is a wandering minstrel and one of the veterans of the old-time minstrel days following the Civil War. Although he is now sixty-six years old, he is still an active black-face comedian.

Women Jockies Come Next

SO far as we know there are no women jockies yet, but there may be a thriving crop of them before long. In England, at any rate, where women are busily upsetting all sorts of ideas about their "place," women have been replacing stable-boys in exercising race-horses, and, as everyone knows, every stable-boy who has a leg up at exercise time hopes to graduate soon into a full-fledged jockey.

The daughters of Sir Robert Wilmot, owner of a large racing stable in England, have shown the way, and the trainer says that they have unusually light and firm hands and that the horses appreciate the change from stable lad to stable lassie.



© International Film Service



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A Room Designed to Attract Aviators

WHIR! The aviator drinking tea in the Hotel Imperial looks up with a start. Surely it is an airplane's motor that he hears! And then he sees it projecting out of the ceiling, while its propeller whirls the air about.

No, the airplane did not crash through the roof. It was placed there purposely by the owners of the hotel. They had decorated the entire room with airplane parts in order to induce aviators to patronize the hotel. The engine hood, with its radiator and propeller, act as a fan as well, and cool off the air in warm weather.

When the engine needs cleaning the mechanic must stand on a ladder to get at it.

Inviting Guests with Bricks

YOU have heard of bricks being used to speed the parting guest on various occasions—usually when there has been a difference of opinion during the visit. To invite guests with bricks, when one is doing so in all good faith, is a new idea. However, it was done, and the party turned out to be a great success.

Each one of the bricks was wrapped in brown paper and sent out as dinner invitations, via parcel post, by the Campaign Committee of the United Building Campaign Fund. As a result of their efforts in this and other ways, \$10,000,000 was raised.

© Keystone View Co.

He Pedals as He Peddles

SPONGES, feather dusters, carpet-beaters, dust-brushes, and wicker baskets are light things to carry, though clumsy. A Dutchman decided to peddle them, and instead of buying a flivver or a horse and wagon, he used his bicycle as a delivery wagon.

He hung hundreds of sponges on the left side of his front wheel, and many bags and brushes on the right side. In front he spread the baskets, and over his shoulders more bags. Though his wares may very easily trip him up, he at least will be sure of falling on something soft.





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A Boy at the Tread-Wheel Irrigates the Fields

EACH country has its own ideas on irrigating dry fields. In China, for instance, it is sometimes done in the peculiar fashion shown above. A water-wheel is mounted in a small stream at right angles to the flow of the current. The water won't turn it over and so a small boy does it tread-wheel fashion.

He holds on to a pole sunk in the water, and pushes the wheel around by stepping on to the ends of the blades. The water is then forced through a trough leading to the fields that need irrigating.

One way to develop a Marathon runner—but pretty tedious after the first hour!

Selling to the Man Higher Up

"ICE cream cones, five cents each!" shouted the small boy standing alongside of the bus. Several passengers on the upper deck looked down longingly at the tray of cones below, when, behold! the tray of cones shot up within their reach. The boy had mounted his tray on a long pole in order to get the trade of the men and women higher up—and he succeeded.

While the bus riders waited in the hot sun for the bus to start they fell easy victims to his plan. And he gathered in the nickels. Or perhaps he charged a dime. Ice cream, like everything else, has become more expensive, and besides, this boy's business is a risky one. Ice cream melts quickly in the hot sun.

Should two or three bus loads pass him up, the ice cream in his cones would run down into the tray and the result would be a total loss.

When this picture was taken there were just four cones on the tray, and eight people on top of the bus. His chances of selling out seem good.



It Was Here Before Columbus

ON a farm near Rosewell, N. M., is an irrigation ditch, or rather a raised irrigation canal, which is one of the oldest evidences of man's inventive powers on this continent. It was built centuries before Columbus learned navigation. The walls of the canal are believed to have been made of sediment taken from a near-by spring, a clay-like material that exposure to the air has made as hard as stone.

The making of two blades of grass to grow where but one grew before through irrigation is a very ancient practice. It was carried on crudely by the Egyptians at least as early as 2,000 B.C.



When You Walk the Ladder Step Goes with You

THERE is now a ladder that has just two steps, one for each foot. As you climb you take the steps with you. There is a pocket in each step into which your foot fits snugly.

The slots along the sides of the ladder in which the steps slip up and down are provided with ratchets that will hold the steps in a fixed position whenever you press down on them. Thus by dragging one foot after the other you can adjust the steps to suit yourself.

How do you get down again? We are not quite certain, but we presume that you reverse the action.



© Gilliams Service

No Smuggling on the Rhine!

PUT! Put! Put! Put! The modern watch on the Rhine pricks up his ears. A launch is running without lights somewhere in the river. He passes the word, a searchlight begins to feel around in the velvety blackness, and a launch flashes into view as the brilliant beam picks it up.

The sentry hails the boat, but gets no reply. Instantly a rattle of machine-gun shots rings out on the night air, and the boat stops.

The combination of machine-gun and searchlight was invented by the British forces to break up smuggling on the Rhine. When the light plays on an object the gun is automatically trained on it.

The gun and the searchlight are mounted side by side on a common stand and turn on the same axis. When the searchlight is turned about to pick up a boat, the gun moves with it. When the boat is spotted, the gun is ready for action, if necessary.

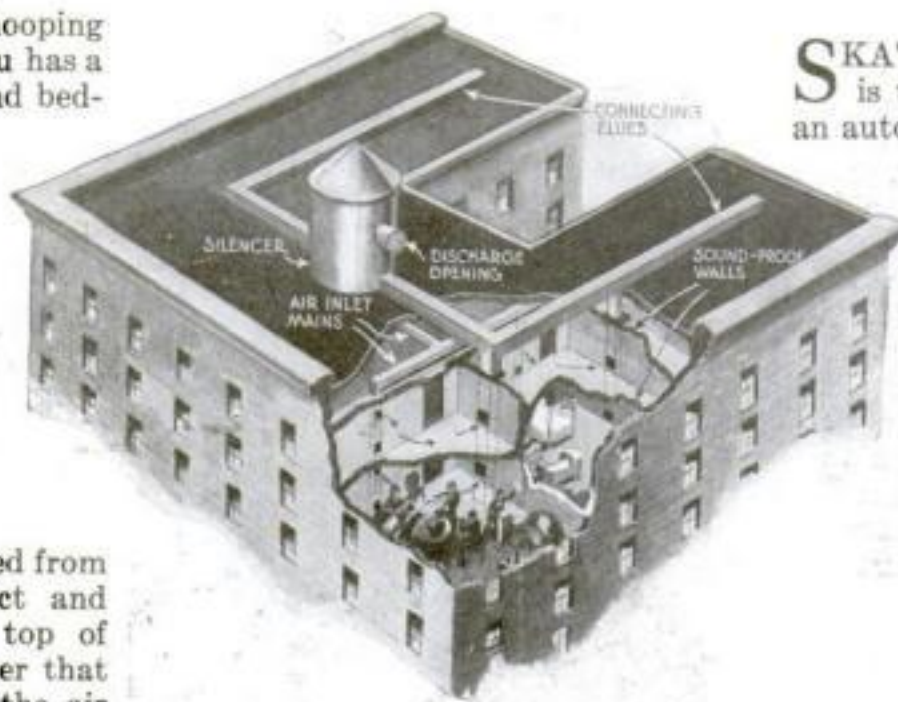


Here's Maxim's House of Silence

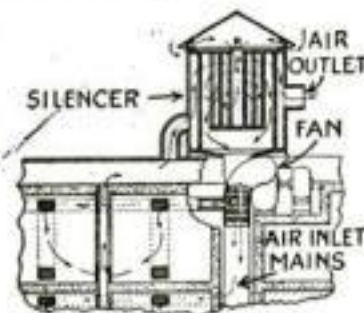
THE baby below you has whooping cough; the man above you has a pianola; and both tune up around bedtime.

But Hiram Percy Maxim, the well known inventor of the silencer for firearms, has come to the rescue. Be not alarmed, he does not intend noiselessly to shoot your neighbors, but to apply his silencer idea to the apartment-house itself. He would build apartment-houses, hospitals, and hotels so that the windows need never be opened. Air is furnished from the roof through a main duct and several branching flues. On top of the main duct there is a silencer that breaks up the noise waves in the air which is entering. As it goes into the silencer it passes through a series of spirals which are enclosed in an inside chamber made of sound-deadening material. By the time the air finally reaches the main duct all the noise has been taken out of it.

In the duct there is a fan for forcing the air down and a coil for heating or cooling it. In winter the coil is filled with steam and in summer it is filled with a refrigerant. The fresh-air openings are near the ceilings of the rooms and the flues for carrying off the foul, used air near the floors.



With the windows closed and the air coming through a silencer on the roof, you will not hear your neighbor's pianola or his baby



As noise waves enter the silencer, they pass through a series of spirals enclosed in a chamber made of sound-deadening material



Sharpen your own skates as easily as you shine your shoes

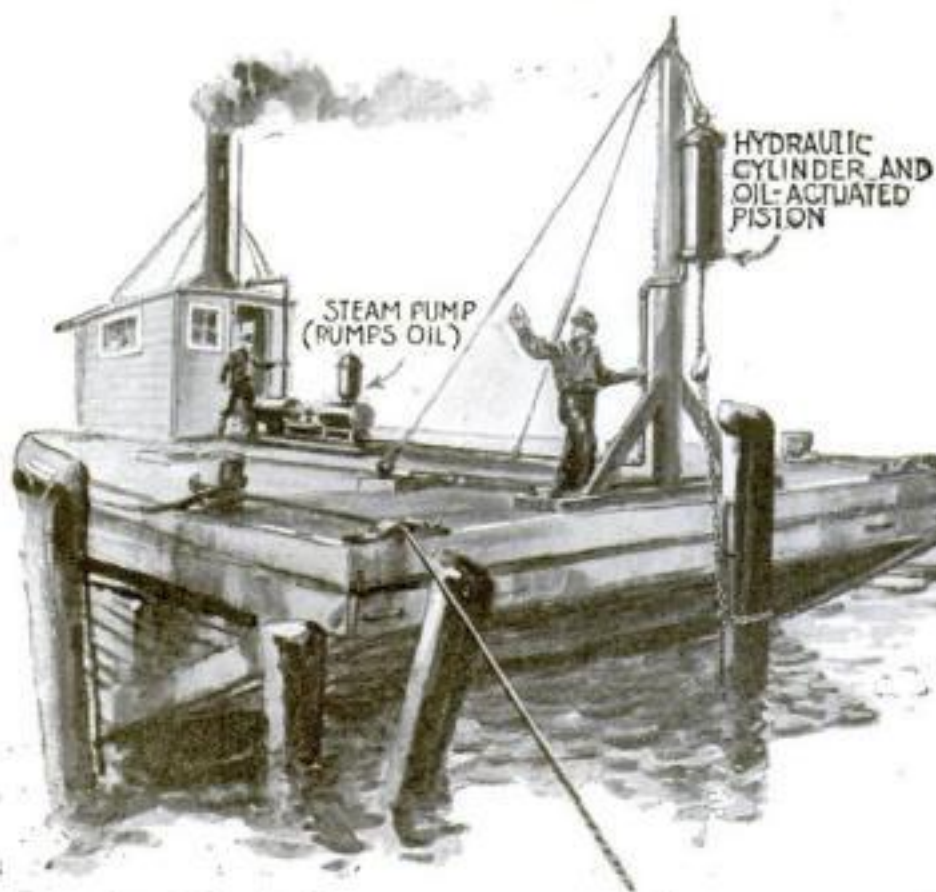
Why Not Sharpen Your Own Skates?

SKATES dull easily and the result is that you skid on the ice just as an automobile does on wet pavement. Every skater should own his own sharpener.

The picture below shows an individual skate-sharpener that has recently been invented.

To use this skate-sharpener, first turn your skates upside down and fit them into grooves in a small wooden stand. Tighten them in place by means of screws, and then rub the upturned edges with a sharpening bar.

Sheet Piling May Be Pulled Out by Hydraulics



Piles may be pulled out of deep water by mounting pump and spar on a scow. The device has a lifting power of eight tons

The small cylinder attached to the spar will pull up sheet piling; a piston in the cylinder has a hook on the end that fits into the eye in the pile; oil is pumped into the cylinder and the piston easily pulls the pile up

HOW can you pull out sheet piling used in cofferdams? One ingenious method is shown herewith.

A heavy steel cylinder with pipe fittings and piston is used. The piston-rod, with a hook on the end, protrudes from the end of the cylinder to engage the holes in the ends of the sheet piles. The cylinder is attached to a tall and strong spar at a height sufficient to reach the normal height of the pile-holes. A pump completes the outfit.

When all is ready, with the hook engaging the eye in a pile, cylinder oil is pumped into the lower end of the cylinder, and the piston pulls the hook upward.

With eight tons of lifting power the device is capable of moving almost anything that can be driven.



Put a Burglar Alarm on Your Baby

KIDNAPPED—not by Stevenson but by a burglar; many mothers are constantly in fear of having this happen to their babies. They always keep a watchful eye on the baby-carriage. Why not attach a burglar alarm to baby and carriage? This has been done, as you will see if you look at the picture below.

Fastened to the carriage just below the handle there is an electric bell with wires running down from it to a battery below. When the mother leaves her child she sets the alarm. Along comes the burglar. Should he start to wheel the carriage away the bell will ring loud and long. Or should he notice the alarm and decide to remove the baby from the carriage he will be foiled again: the alarm is also attached to the baby.



No one can steal this child without setting off an alarm; the alarm is attached both to the carriage and the baby

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Bats Made of Wood Strips and Glue

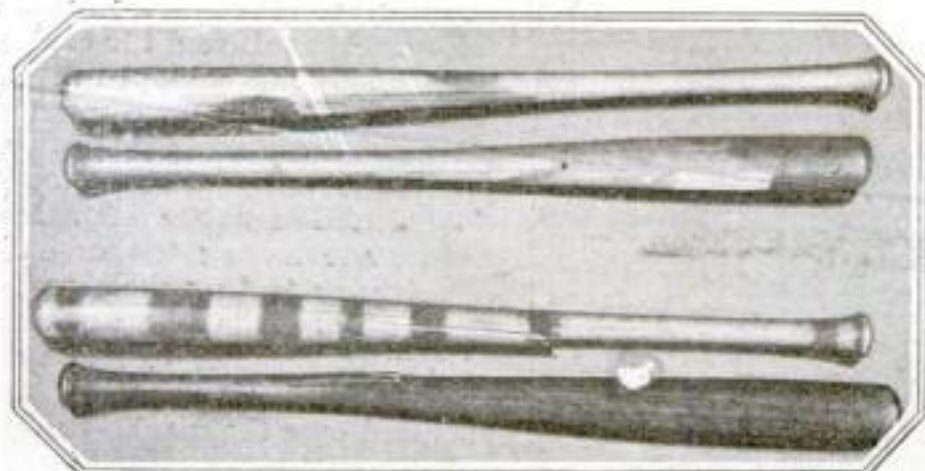
A NEW baseball bat, bidding fair to make its appearance in major baseball, has been developed at the Forest Products Laboratory, Madison, Wis.

It is made by gluing together strips of wood obtained from board edgings and waste stocks. The strips are selected to give clear material and are dressed to a smooth surface before being glued together. The moisture content is also equalized. The laminations may vary in thickness from a half to three quarters of an inch.

The photograph below shows several bats made by gluing together three laminations, three quarters of an inch thick and two and a half inches wide. Two bats, as shown in the picture, failed while being used.

In both cases the failure occurred in the wood, while the glue held unbroken, even under the severe pounding the bats received.

The laminated bats seemed to give as good service as the solid bats on the field, and the players showed no preference for one kind over the other.



These bats were made by gluing together strips of wood; in the two imperfect bats the wood cracked—not the glue



From one angle this statue of a woman smiles at you derisively; from another you see the mask torn off and face and body tense with anguish

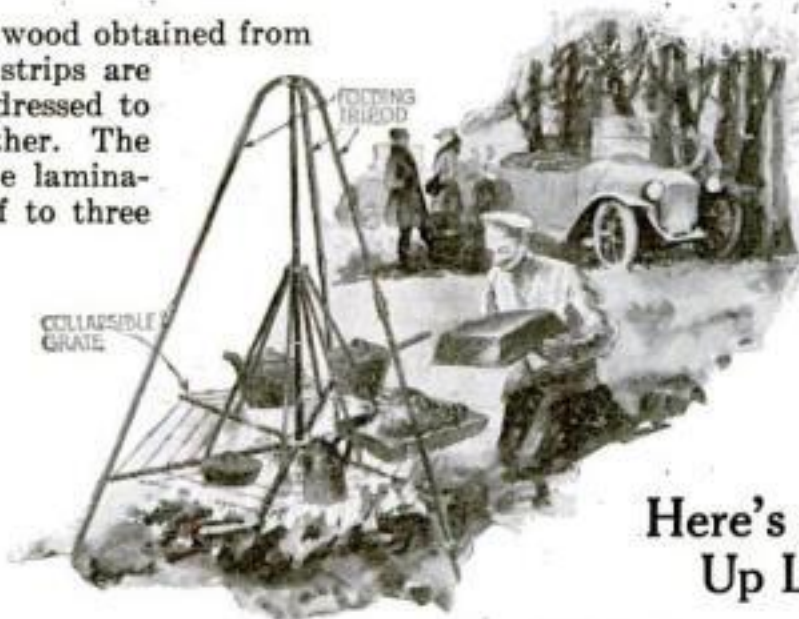
Turns Two Faces to the World

AS you walk through the Garden of the Tuileries in Paris, you come upon the statue of a woman who slouches carelessly on her pedestal and looks down at you with an unpleasant, derisive grin. But if you walk around her you will see the real woman with the mask torn from her face.

Her head is thrown back in anguish, her teeth clenched, and her eyelids drooping with pain. Her body is no longer slouching but tense. She holds the mask in her left hand.

This remarkable statue was first made in clay sixty-five years ago by Ernest Christophe, who called it "Sorrow."

Twenty-one years later Christophe remade the statue in marble and gave it a new name—"The Mask."



Here is a collapsible stove for campers. The grate is mounted on a rod and opens up umbrella fashion

Here's a Stove that Opens Up Like an Umbrella

"LET'S go camping—build a fire in the woods and cook our dinner on it," someone says. And then you remember how last time somebody kicked the log you were using to prop the coffee-pot, and over it went—just as it was going to boil, too. And you jumped to save it, and tipped over the frying-pan, and its contents were unfit to eat. "No! Give me a good steady stove at meal-time," you reply.

Now Roderick D. Turner and Walter G. Dedolph, of Mount Vernon, Washington, have together invented a camp-stove that is the very thing you need. When not in active service it can be folded up like an umbrella and carried just as easily.

A central rod is driven into the ground and supported by a tripod that has adjustable legs. Mounted on the central rod is a collapsible grate that may be opened up and flattened out. You rest your pots upon it. The grate is supported by wires from the central rod. The whole stove weighs but ten pounds.



Hot iron is poured into these machines and whirled into pipes by revolving molds

Whirling Molten Iron into Pipe

IF you whirl a string with a weight on the end and then let go, what happens?

It flies off at a tangent. This is caused by what is known as centrifugal force; and the same principle is applied to many pipe-casting machines.

The hot iron is poured into the machine, and it lands on a whirling steel mold that is properly cooled.

The liquid is flung against the sides, hardens, and comes out a perfect pipe. The pipes that are made in this way are of uniform thickness, and, though thin, are very strong.

How Will You Have Your Gas?

JUST as we get expert in sight-reading the gas-meter, along comes an Englishman with a new scheme for measuring the gas we burn. He proposes that it be sold by heat units instead of by the cubic foot.

This doesn't mean that the gas-meters will be scrapped. They will go merrily on registering cubic feet, but in order to understand your bill you'll have to translate that into heat units.

To do this you have only to remember that the unit of heat measure is the quantity of heat required to raise a pound of water one degree Fahrenheit. If, then, when Polly puts the kettle on it contains two pints of water, it will require 380 heat units to bring the water to the boiling point—212° F. It is proposed that the new "gas unit" shall contain 100,000 such thermal units, so that one "gas unit" will have sufficient heat to boil two hundred and sixty such kettles as Polly put on.

You Can Tuck This Piano Under Your Arm

"OH, what a pal was Mary!" sounds just as convincing on a small sixty-pound piano as it does on a baby grand—particularly so since the tone of the new small piano is harp-like, and Mary is dead.

What does this tiny piano look like? The picture below will show you.

It is so small that soldiers at the front were able to tuck it

away in their equipment and take it out whenever they had a few hours' rest. The piano has a regular five-octave range, but tuning-forks instead of strings are used to produce sound. This, of course, does away with the necessity of tuning the instrument.

When you strike a key, a hammer drops on a tuning-fork, which is set to vibrating and produces a tone.

The fork is connected by a spring to a sounding-board that reinforces the tone.

The piano is also equipped with a loud pedal. When you step on it a damper that rests on the end of one arm of the fork is raised, and the fork is free to vibrate loud and long.



This tiny portable piano weighs but sixty pounds; it has a full five-octave range, but the tones are produced by tuning-forks instead of strings

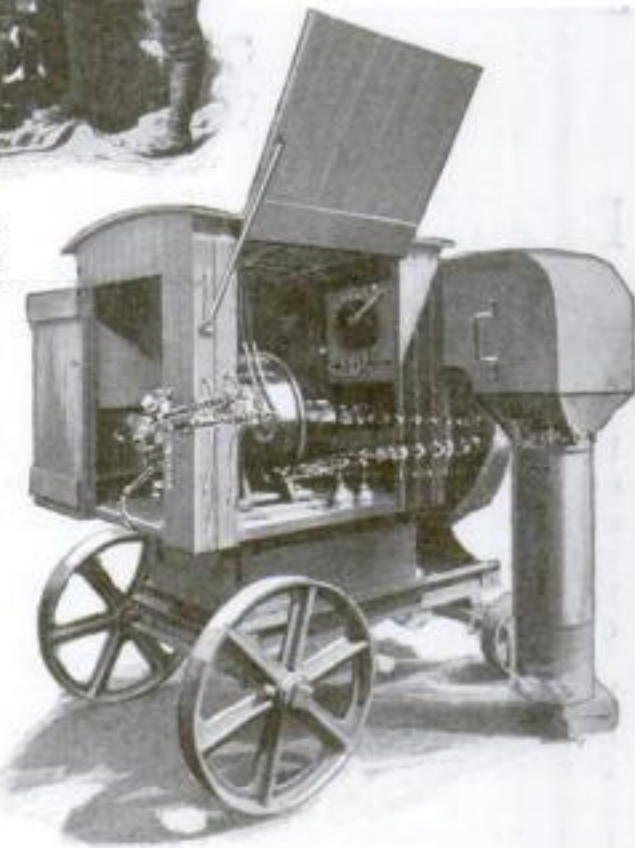
Saving Fallen Fruit

WHEN a strong wind blows, a large number of lemons, oranges, and grapefruit that are nearly ripe drop to the ground. Many are bruised, and many more are instantly attacked by ants and worms. The fruit is a total loss unless quickly gathered.

If they are picked up promptly, the uninjured parts can be turned into by-products. The lemons can be used to make lemon oil, citric acid, citrate of lime, and dried lemon peel; the oranges will yield vinegar, marmalade, syrup, and orange butter much like apple butter; the grapefruit, juice and marmalade.



He is testing out by-products made from bruised lemons, oranges, and grapefruit

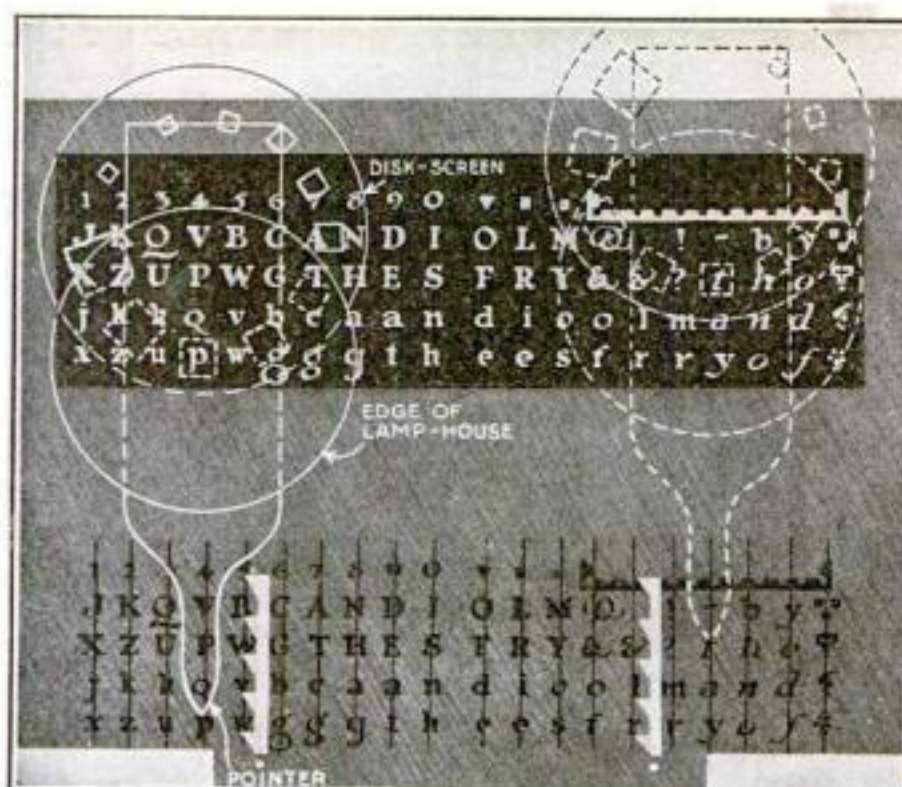


Constructed to cool off overheated underground electric cables

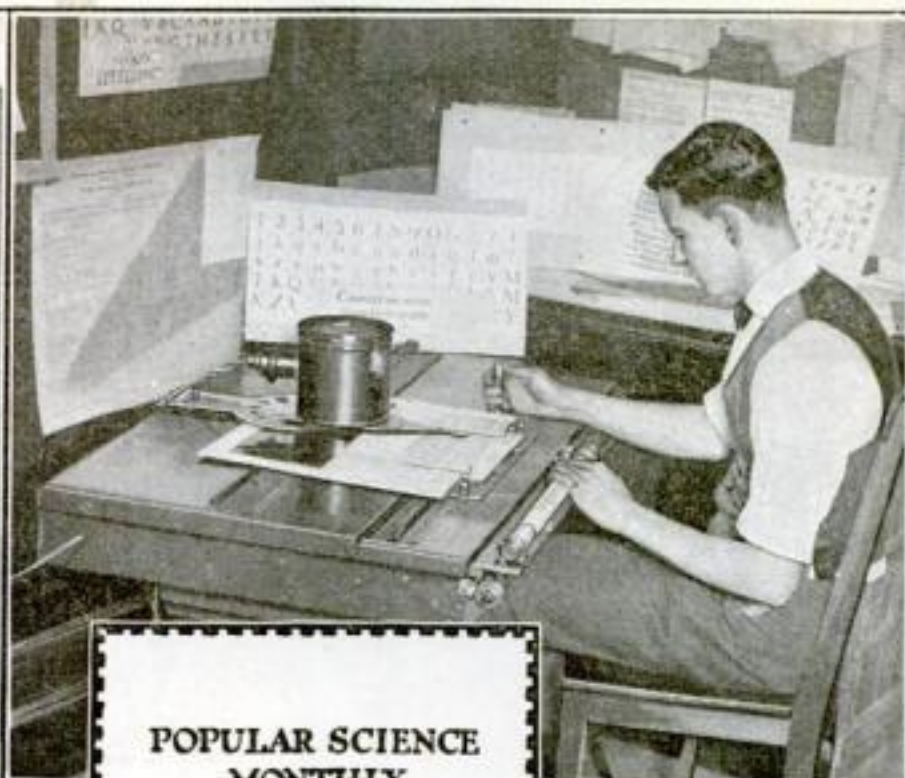
Cooling Off Underground Electric Cables

UNDERGROUND electric cables frequently become heated to the danger point. A company in Detroit has constructed a portable blower that will cool the cables.

The blower is equipped with a twenty-eight-inch fan connected to a 7.5-horsepower motor. A discharge pipe from the blower is inserted in a circular sheet-iron plate having the same diameter as the manhole to be covered, and the two are then cemented together to make an airtight joint. The circular plate is fitted over the manhole nearest to the overheated section of the cable, and the motor is started.



The upper part is an ordinary film negative upon which has been photographed an alphabet of type. The lower section serves as a guide for the pointer, the upper part being covered by the lamp-house when in use.



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The operator prints letter after letter by simply moving the negative and pulling a lever. The display card on the left demonstrates that the machine allows as great latitude in the spacing of letters as does hand work.

Hand Lettering by Machine

WHILE printers may readily set up advertisements and cards on linotype and monotype machines, it has always been difficult to prepare those displays which are to be photographed on copper and run as a solid block—a half-tone engraving. It is to fill this missing link that Isaac Bunnell of New York has invented the desatype.

The machine does lettering, the same sort of lettering that an expensive artist does, and in about one tenth the time. Moreover, its range in style of lettering is much greater than the ordinary artist possesses, for, in fact, it uses the best work of all artists. Practically anything that a graduate professional can do, the machine can do, and keep it up in unending variety all the day long.

The operator first clamps a rough dummy layout on a platen at the

point shown in the illustration. Then from his file he selects the type-card which carries the style of lettering called for in the dummy. These type-cards are negatives, and a complete set of them, like fonts of type, contains the various sizes and styles of letters. The selected card is put in the machine and moved around until the letter desired, "P" for example, falls under the index, or pointer. The operator then knows that the "P" on the film part of the type-card is under the lamp-housing, ready to print.

Pulling on a short lever at his right, the operator causes the lamp within the housing to light up and send its rays down through the clear place in the negative and so print the letter the clear place corresponds to—suita-

ble sensitized paper being mounted on a roller beneath the lamp-housing in such a way that it can be affected properly by the oncoming rays. Adjustment of another lever sets the apparatus over one space, ready to print the next letter, and in this way the process continues. An automatic timer on the lamp gives each letter equal exposure.

After the printing of the layout is completed, the part of the sensitized paper used is torn off its roll, and developed and fixed just as ordinary "slow" photograph prints are handled. Immediately the black lettering stands out on a white background, just as if a professional artist had done it.

How They Are Chasing the Rats Out of England

ENGLAND'S full of them—the black Irish rat, the brown Alexandrine rat, the common brown rat, and ye olde English black rat. As a result England has had a rat drive, scheduled to last a week—the week being officially called "Rat Week." Besides using traps and poisons to get 'em, ferrets were put on the job. Here you see three ferrets ready to start on a tour through a huge woodstack at Aldershot.

This is, briefly, the history of England's rats: until the first half of the eighteenth

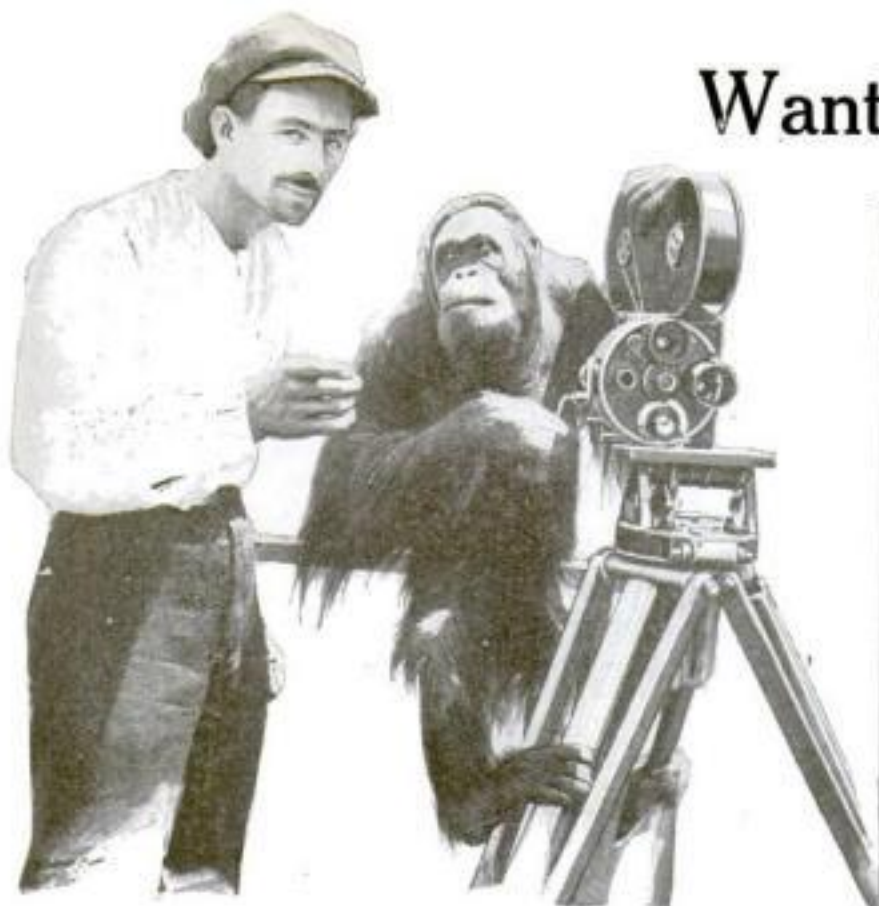


During "Rat Week" in England, ferrets were set on the trail of many rats; those shown here are ready to tour through a woodpile.

century the old English black rat reigned supreme; but then the common brown rat invaded the country, coming by boat from somewhere in Central Asia, and bringing with it the bubonic plague. This fierce little animal nearly exterminated its black brothers.

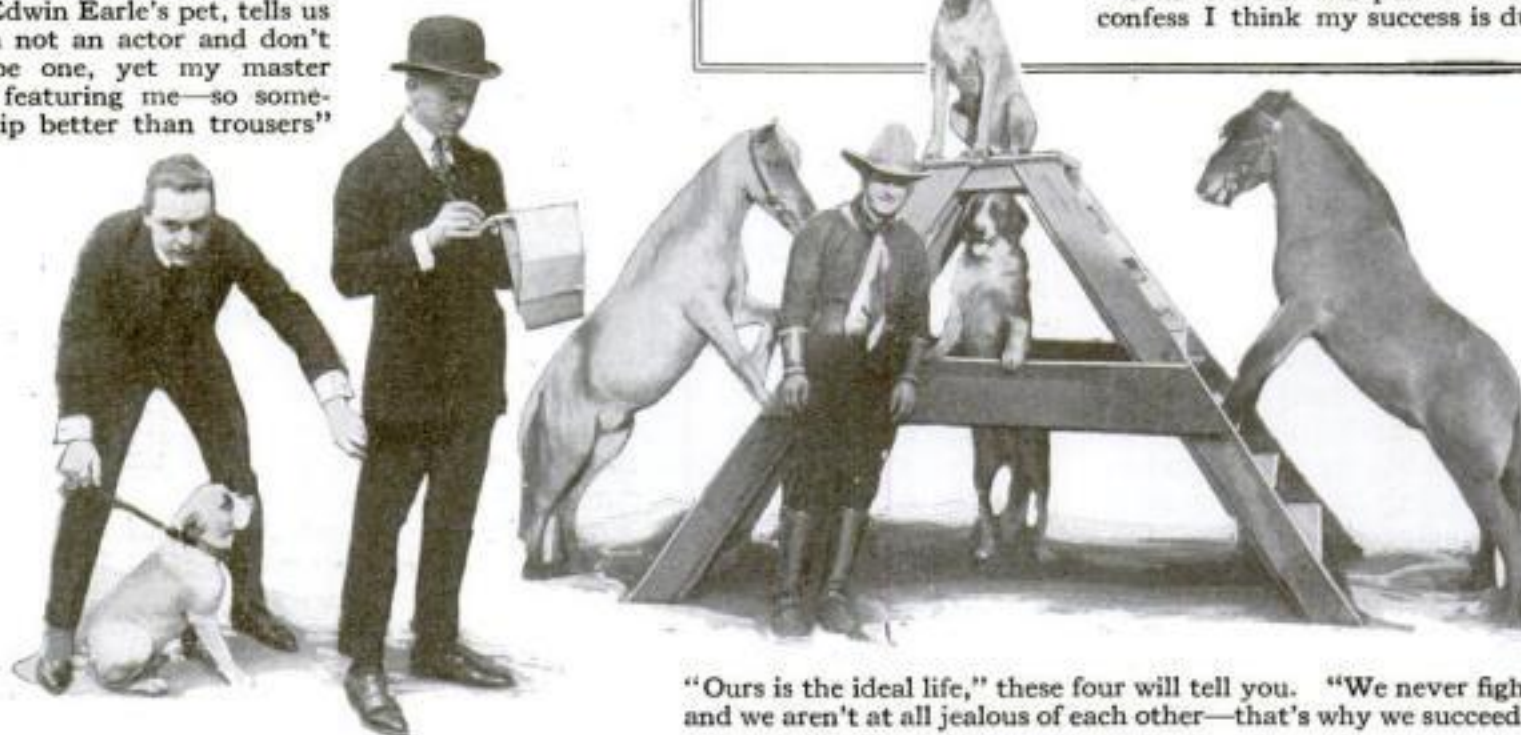
The brown Alexandrine rat was imported later. As for the Irish rat, it is a black variety of the common brown rat and is not seen very often. Whether native or foreign, rats are great disease-carriers as well as voracious guests at the nation's table.

Want to Be a Movie Star, Fido?

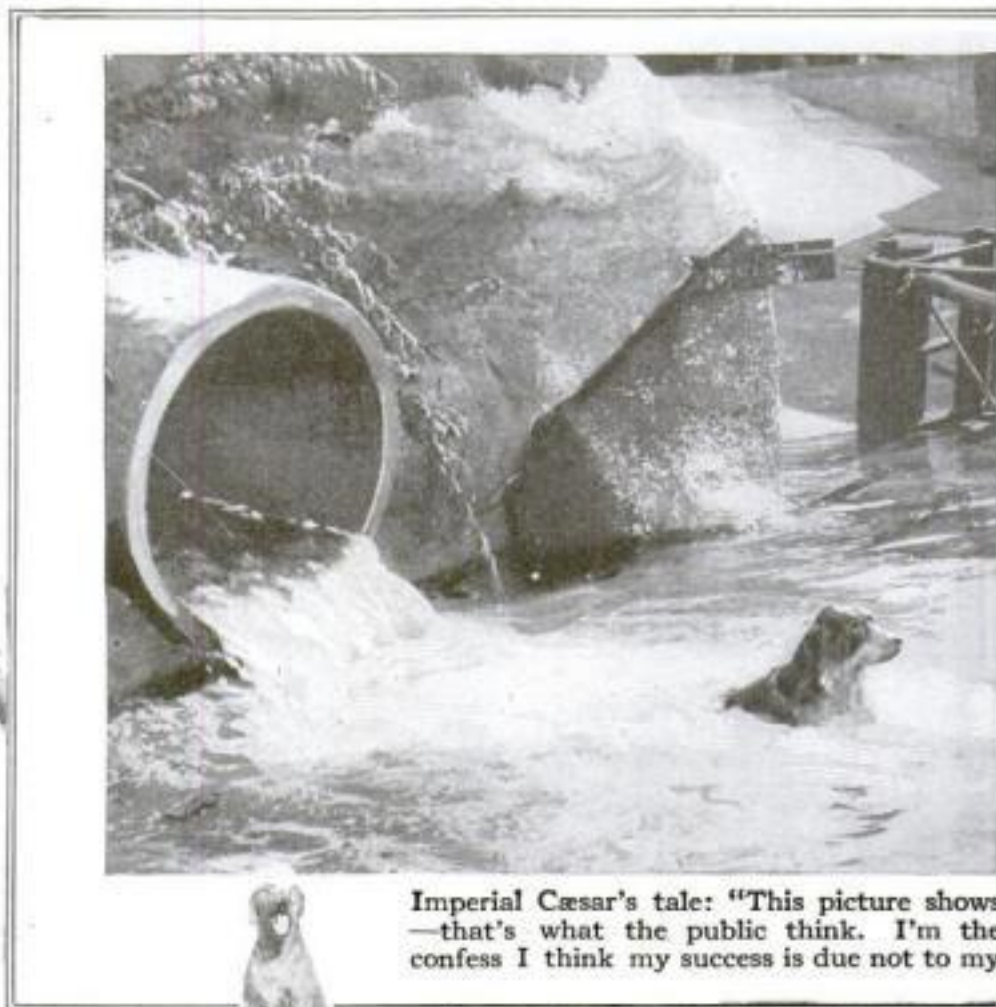


Says Joe Martin, orang-outang: "Follow master—that's my motto; I copy everything he does. As you see, today, instead of acting, I'm the camera man; by being able to help out in a pinch, I have made myself quite valuable—and really these men's jobs are simple"

Murphy, Edwin Earle's pet, tells us this: "I'm not an actor and don't want to be one, yet my master insists on featuring me—so sometimes I nip better than trousers"



"Ours is the ideal life," these four will tell you. "We never fight and we aren't at all jealous of each other—that's why we succeed"



Imperial Caesar's tale: "This picture shows—that's what the public think. I'm the confess I think my success is due not to my



Here's Joe Martin again: he's going to give the baby pig a bath under a hydrant spout. Joe says, "Curly Stecker has really taught me nearly all I know; he is a very good trainer: but then, you know, I film well"



Says Kazan: "I am a full-blooded Russian wolf-hound and thank my parents for my beauty—I might have been a cur! Good looks do help in the movies, but I have incidentally cultivated a most fascinating smile"

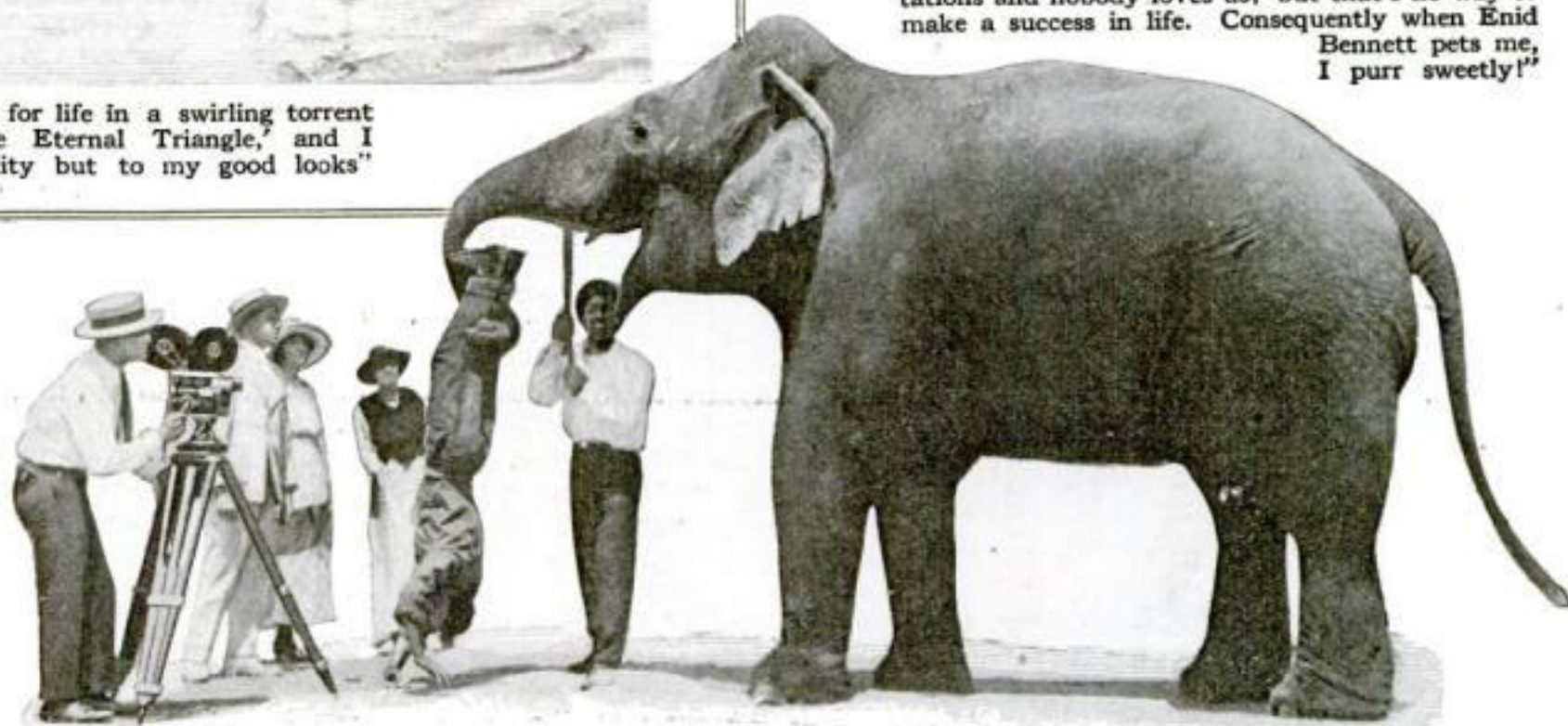
We'll Tell You How to Do It



me struggling for life in a swirling torrent hero in 'The Eternal Triangle,' and I histrionic ability but to my good looks"



Here's baby tiger's tale: "We tigers have fierce reputations and nobody loves us; but that's no way to make a success in life. Consequently when Enid Bennett pets me, I purr sweetly!"



Says Charlie, the elephant: "Had I stayed in the old country I would have been nothing but an ordinary laborer: here in America I am an actor of no small fame. I have a fine memory and so this movie game is all very simple—one rehearsal is enough for me"



The extras speak: "All morning we were starved; then they let us loose in a grocery store and we made for the pieces of raw meat that we smelled. All the while the camera man was grinding away. Foolish, don't you think?"



Ethel says: "Once I lived in a Zoo; but that easy life kills ambition, so I got out before it was too late. I went into the movies and have starred in 'The Lion's Claws,' 'Lost in the Jungle,' and 'The Lure of the Circus'"



© International Film Service Co.

He looks like Santa Claus, and he is one; all through the year he makes Christmas toys; thus he is able to earn his living

Toy-Makers in Santa's Work-Shop

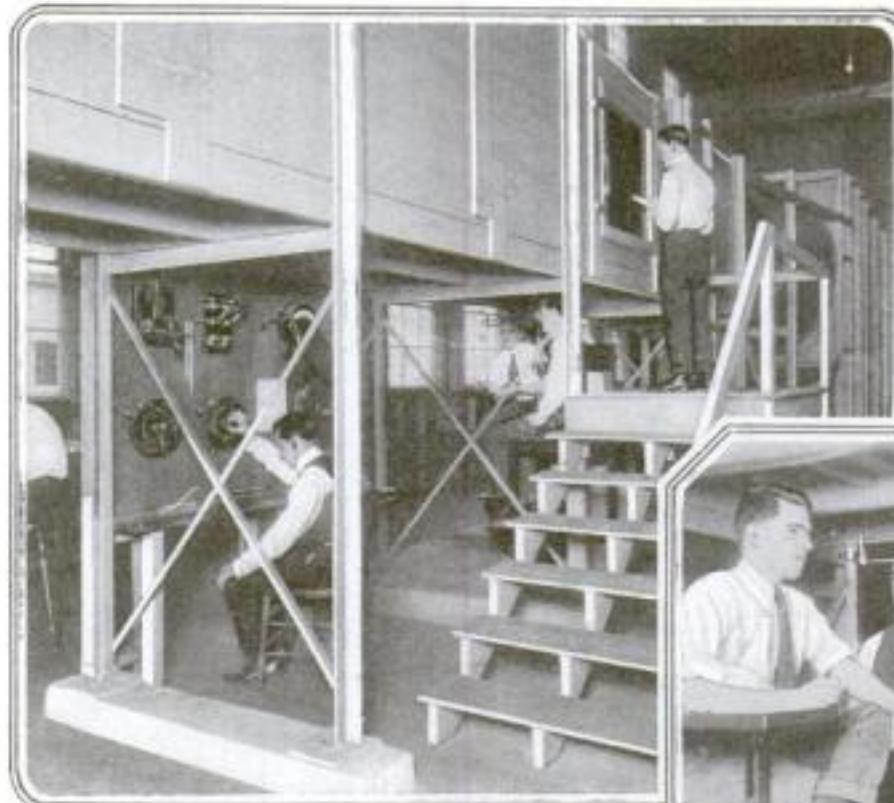
ALL through the year, when you have forgotten all about Santa Claus, eighty very old men and women are patiently making Christmas toys. They had thought they were too old to be of any use in the world until the New York Association for Improving the Condition of the Poor started a small toy factory for them. The finished toys are sold in a store and the profits go to the workers. Thus they are able to earn a living.

When the factory was started there were only about ten workers, but now their number has increased to eighty, and they have moved from their small work-room to a much larger one.

Using Compressed Air to Mix Paint

READERS of the POPULAR SCIENCE MONTHLY have been made familiar with "paint-guns," which eliminate laborious brush-work on rough jobs by using compressed air to spray the paint on the surface to be coated. Now an ingenious workman has called in compressed air to save the back-breaking labor of stirring paint. In his shop, as in many others, a large supply of paint is kept always on hand. It is necessary to stir the paint from time to time to keep it properly mixed and ready for service.

There happened to be a high-pressure air supply handy to the paint-room, so the workman rigged up a double wooden paddle for each paint-tub with the paddle shaft projecting above the top and held in place by cross-pieces. When the paint needs stirring a pneumatic reaming tool is slipped over the end of the paddle shaft, the paddle is whirled rapidly around, and the paint is thoroughly mixed in a surprisingly short time. It is necessary only to shift the reaming tool from tub to tub to stir the whole lot.



The man on the landing is looking through a glass window at a small model airplane fastened inside of a wind-tunnel; the man to the left is regulating the speed of the wind that he is sending through the tunnel; and the two men directly under the spot where the airplane is fastened are reading an aerodynamic balance that tells the effect of the wind on the airplane. They can be seen more plainly in the picture at the right.

Should Home Look Like This?

"SQUARE houses belong to the devil." This startling statement was made by Mr. C. N. Wisner, a New Orleans inventor—not in a campaign against the landlords of apartment-houses, but in behalf of the new round house Mr. Wisner has invented. A model of one of these houses is shown below. At first glance it looks like five pots with their lids clamped down, but you soon notice the windows and the halls that join the rooms together, each seeming pot representing a room. You can start with one, and add one by one as you wish. They are made of concrete cast in steel molds.



© Keystone View Co.

These are not five pots linked together, but five rooms, hallways, and closets—a model of what the inventor calls the perfect house

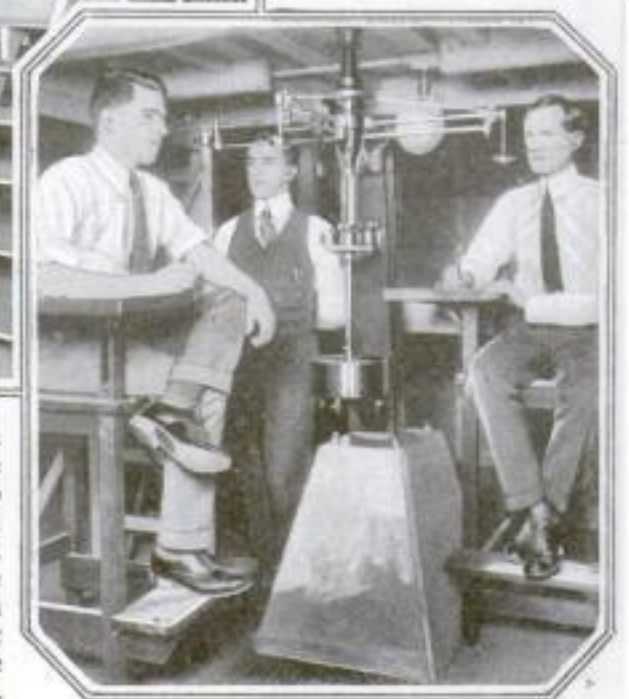
How Much Wind Can She Stand?

WHIR! Whiz! The wind shot through the wind-tunnel, and the small airplane quivered. Just below her, two men glued their eyes to a strange-looking instrument known as an aerodynamic balance, and alongside of her another man looked in at her through a glass window. They were testing her to see how she stood up under the force of wind of varying velocity. A fourth man regulated this speed.

The airplane is a tiny model, one twenty-fourth as large as a regular airplane. The wind-tunnel runs the whole length of the room and is four feet square.

The balance is the only one of its kind in the country, and is so accurate that it can measure to within one ten thousandth of a pound. By adjusting a series of weights the men can determine the effect of the wind on the airplane. The whole outfit is located in the Massachusetts Institute of Technology, and it was used by the army and navy throughout the war.

Photographs © Wide World Photos



One of the Great Unknowns

This Edison of the rifle-barrel won't quit work till he quits life

By Herbert Asbury

BOARD a tunnel train under the Hudson river, and get off at the Exchange Place station in Jersey City. Then walk down Hudson street, perhaps the dirtiest and noisiest of all the dirty and noisy streets of Jersey City, until you reach Morris street, in the midst of a multitude of machine-shops and foundries whose clangor and clamor is never stilled, and within sight and sound of the bellowing steamships that line the Jersey City docks and piers. Walk down Morris street to No. 18, a dingy and dilapidated old structure, and climb the stairs to the fifth floor. And there, while your ear-drums are assaulted by the screeching whine of a planing-mill on the same floor, you'll see at the head of the stairs a sign:

POPE'S BELL

Bell out of Order. Knock on the Glass

You knock and knock, and then you knock again, trying vainly to compete with the planing-mill and the noises of machinery that come filtering up the stairs. But finally the planing-mill subsides for an instant, you pound on the door with all your might, and suddenly it is opened by an old man with very gray hair, a homemade cigarette drooping from his lips, a little black cap on the back of his head, and a twinkle in his bright gray eyes.

He is the Edison of the rifle-barrel. His name is Harry M. Pope, and he is hard to find.

Truly he is a prophet without honor in his own country. He is known wherever rifle experts gather and wherever fine rifles and fine ammunition are manufactured; but in his own home town the rank and file of the population—and the big business men, too—never heard of him. He has lived in New Jersey for almost fifteen years, and in all of that time his work-shop has been in 18 Morris street—but his name does not appear in the city directories, nor in the telephone directory, and the Chamber of Commerce of Jersey City has no record of him. The writer succeeded in finding him only because an ancient gunsmith on the outskirts of the city happened to remember his address.

The shop in which Mr. Pope manufactures fine rifle-barrels and does the delicate work of adjustment seems to an outsider to be cluttered with tools

in hopeless confusion. But there really isn't any confusion at all; he just hasn't room for all his tools. Every nook and corner of the place is jammed with lathes and punches and dies and tools of all sorts—with the exception of a small space in a corner.

That space holds a rather dilapidated couch, with a faded blue neck-



The shop may seem to you to be a hopeless clutter of confusion. It is not. The fact is, Mr. Pope hasn't room for all the lathes and punches and dies and other tools necessary in his business of making rifle-barrels

tie thrown carelessly upon it, and a pair of heavy army shoes peeping from beneath it. This is where Mr. Pope does most of his sleeping—when it occurs to him to sleep. He doesn't sleep a great deal; he thinks, with Edison, that it is a waste of time.

He eats regularly if he happens to think of it, otherwise only when he becomes so hungry that the matter of food intrudes itself. He has a home, of course, and a family,—two of his boys were in the American Army during the war,—but he is so much in love with his work that he sleeps in his shop some four or five nights a week.

"But I'm getting a little tired now," he said, "what with all this noise and so much work. I'd like to be in the country for a while."

"Are you thinking of retiring?"

"Retire!" exclaimed the wizard of the barrels indignantly. "I'll retire when I'm dead! What I meant was that I'd like to have my shop in the country, where I could get a bit of fresh air."

The postmarks on the great mass of

letters piled on Mr. Pope's work-bench demonstrate that, if without honor in his own country, he certainly has great honor in Canada and in California and Maine and all of the other states of the Union.

Mr. Pope has known and loved rifles all his life.

"I began shooting when I was a kid," he said, "and I've been shooting ever since. I had a hard time finding a gun that would shoot like I wanted it to shoot, and like I knew it ought to shoot, so I went to work and made one. I liked the work so much that I kept at it."

Manufacturing rifle-barrels is about everything that Mr. Pope does. Repair work is distasteful to him, and repair work on barrels is the only thing of that sort that he will do at all. His delight is to take a perfect action direct from the factory and fit that action with a barrel of his own making—and the combination is a gun that wins championship matches. He has made many rifles of that sort; for, after all, it is the barrel that determines whether a weapon is a rifle or merely a piece of junk in the form of a rifle, and some of the guns that he has made have been considered by experts the finest in the world, and all of them in the hands of marksmen have

brought home record scores and medals galore. Many of these prizes and medals the visitor will find hung on nails in a corner of Mr. Pope's workshop, because he can shoot about as well as he can make rifle-barrels, and has won many big rifle tournaments.

Mr. Pope is a native of New Hampshire, and possesses a little more than his rightful share of New England reticence. Like all true artists, he is modest. However, it was learned, by dint of persistent questioning, that he has been making rifle-barrels for more than thirty years. He has had shops in various New England towns, and once went to the Pacific coast. But he lost everything he had in the San Francisco earthquake, and then returned to the East and settled in Jersey City.

Even if he achieves that dream of a place in the country, he probably won't see very much of it, because the most striking impression that one gets of Mr. Pope is that he will continue to work with his rifle-barrels for eighteen hours a day as long as he lives.



She saw the burglar coming, and pushed two buttons concealed on her bed; then she threw up her hands as requested

Announcing Mr. Burglar

"BULLET Johnson," burglar, ransacked the ground floor of a house in Philadelphia and then invaded the owner's bedroom. "Keep your hands in sight and your mouth shut," said he, and his victim promptly obeyed. A few minutes later "Bullet" left the house, and several policemen ran out to meet him. He is now serving a five-year sentence in prison.

How did the police find him out? In the side of his victim's bed two push-buttons were literally embedded. When the woman in bed heard the door creak and saw it move as the burglar entered, she pressed both buttons, one of them once, the other twice. A bell rang in the house on each side of her, and the neighbors woke up and called the police.

Wilfred B. Henderson originated the idea.

His house was one of eighteen on his block, and there had already been six burglaries near by. He suggested that electric bells with push-buttons be placed on one of the beds in each house, and that they be wired together, so that each house might ring up the houses on each side should a burglar appear. One ring means the house on the left and two the house on the right.

Can You Name the Seven Seas?

OMAR KHAYYAM and Kipling both talk about the Seven Seas. What are these Seven Seas?

They are really the five oceans—the Arctic, the Antarctic, the Atlantic, the Pacific, and the Indian oceans. And the number seven is derived by dividing the Atlantic and Pacific oceans into halves, and calling these halves the North and South Pacific and Atlantic oceans.

The reason for this is supposed to be that the number seven symbolizes completeness or perfection. As early as the beginning of Christianity, the rabbis affirmed that "God made the Seven Seas."

Shop-Lifting Up to Date

"LET me see that necklace in the case over there," says the lady to the salesman. He goes after the necklace and brings it back; she decides not to take it, and goes out.

Shortly after she has gone various articles are found to be missing. They went with the lady, who was a shop-lifter. The method of working was to get the salesman out of the way by a subterfuge.

While he was gone she "accidentally" knocked down sundry small articles, which she kicked close to the counter. Shortly afterward, under cover of tying her shoe-lace, she transferred them to a couple of strong elastic garters that she wore around her legs. After her real business had been accomplished the proposed purchase, of course, no longer interested her.



A shop-lifting device that emanates from England; London stores suffered accordingly

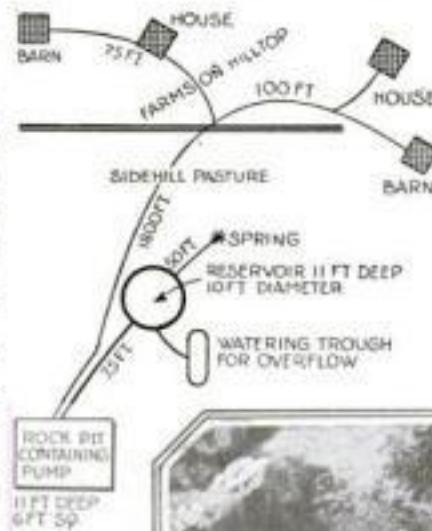
Harnessing a Spring to Pump Itself

BY harnessing a spring so that it pumps itself, two farmers who live on opposite sides of the road on an Iowa hilltop near the Mississippi river have running water in their homes and barns. Their farms lie on top of the hill. The long timbered slope of the hill is owned by one of the farmers and used as a pasture. Near the top of the hill a spring bubbles out of the limestone.

The spring was cemented in to keep out impurities. Fifty feet below, a cement reservoir eleven feet deep and ten feet in diameter was built in the ground and the water from the spring piped to it. Seventy-five feet down the ravine from the reservoir a square rock-pit eleven feet deep was made, and an automatic pressure pump installed in it. A two-inch pipe was laid underground between the reservoir and pump. From the pump a

smaller pipe was run to the top of the hill, a distance of eighteen hundred feet and a lift of four hundred feet. At the top it branched into two pipes.

The system works automatically. Open any one of the faucets on the two farms and the pump begins to work. The water, as it drops through the pipe from the reservoir to the automatic pressure pump, works against the piston with a pressure of forty-five pounds to the inch, driving the piston with a force that sends the water uphill. When the faucets are closed, the back pressure of water holds the piston so that it cannot work.



The water from the well above is automatically pumped to two farms. The pump is enclosed in the house to the left. When any faucet is turned on the water works against the piston of the pump

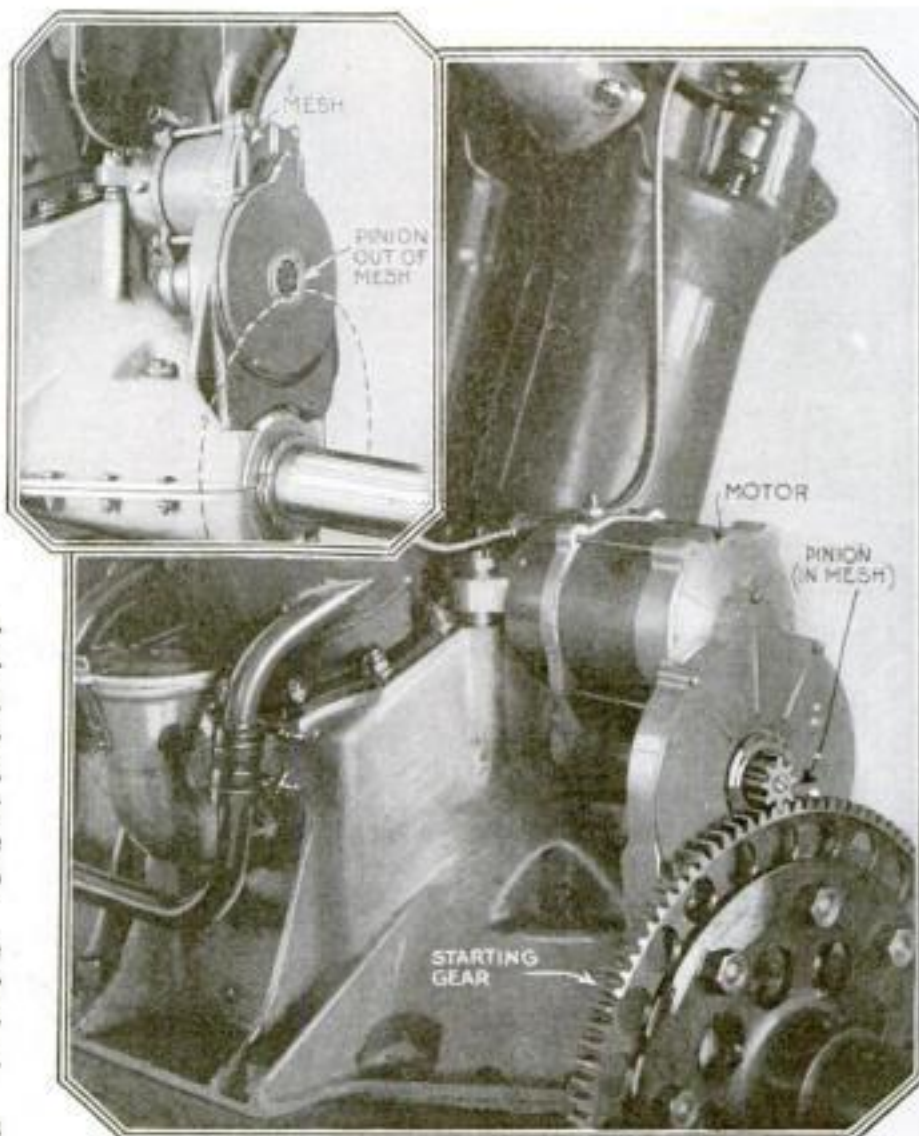
Self-Starters for Airplanes Introduced by the N. C. Craft

EVERYONE who has read the magazine sections of the Sunday newspapers during the past year knows that the engines of airplanes are started by man power. You have probably seen pictures showing a team of three or four men, hands linked, starting the propeller, the outside men pulling the man who actually turned the propeller out of the suction of the revolving blade at the critical moment.

With millions of automobiles equipped with self-starters, the question has often been raised as to why airplanes were not fitted with a similar device. One thing that prevented this was the additional weight necessary to install such equipment.

All these problems have been overcome by a starter manufacturer, the first apparatus being fitted on the N. C. boats.

The new apparatus consists of a small twelve-volt motor operated by a storage battery weighing twenty-six pounds.



Now comes the self-starter for airplanes, a feature long needed by pilots. No more danger of injury to the mechanic if it is attached to your airplane

The current revolves the armature shaft of the motor. A small pinion on the end of the armature shaft drives another small eight-toothed gear, which meshes with a larger gear attached to the propeller-shaft, so that the engine-shaft and propeller are automatically started. The starter turns the engine at from forty to fifty revolutions a minute, and the storage battery has sufficient capacity to start the engine one hundred and fifty times.

The pinion on the drive-shaft does not mesh with the shaft gear until the starter button is pushed, when the pinion automatically slides along the screwed end of the shaft until it drives the shaft gear to the propeller. As soon as this begins to revolve faster than the driving pinion, it is thrown out of mesh and the battery current conserved for the next starting operation. This apparatus opens up great possibilities for the future.

WHALING has been followed for hundreds of years. In the old days of hand harpoons only the sperm, bowhead, and right whales were hunted; but today, with modern equipment, every kind of whale, from the giant blue whale or sulphur bottom to the killer whale, is sought.

The whale yields many products of commercial value—whalebone, oil, fertilizer, and glue. In Japan whale meat has become an important item on the menu of the poorer classes, and it is

Whale Ho!—There She Blows!

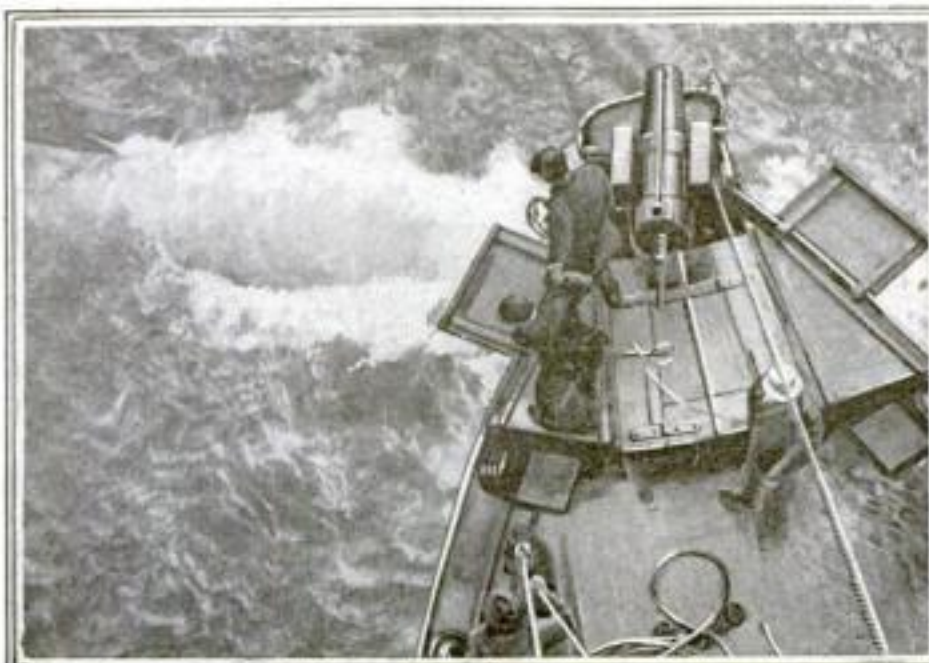
canned and shipped to all parts of the empire.

Whale-hunting is a dangerous pursuit, and whalers are a rough, hardy lot. They must withstand all kinds of weather in their boats, which are small and round-bottomed to facilitate manipulation and speed.

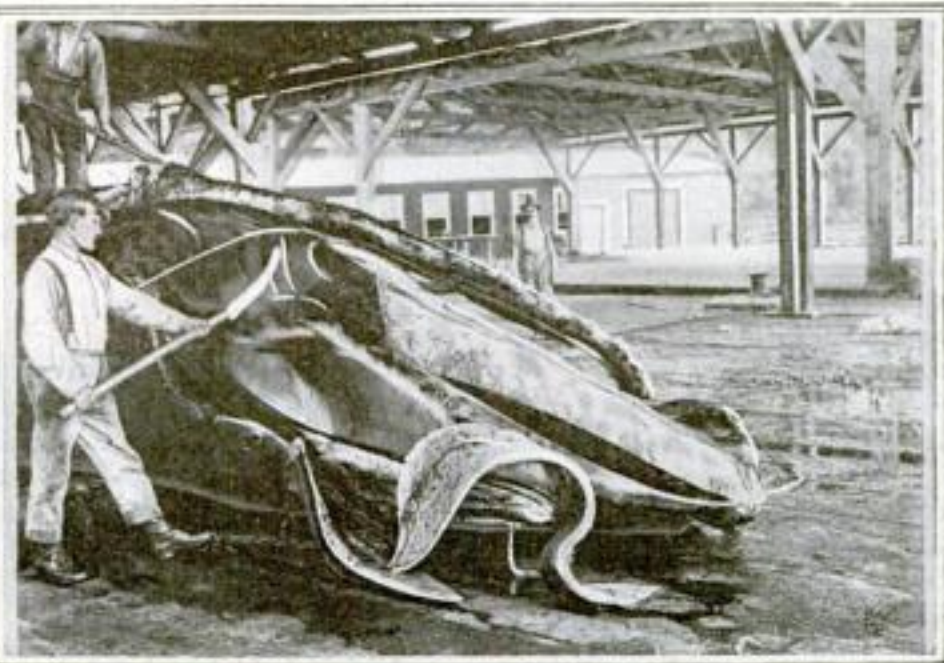
It often happens that a whale, harpooned from the steamer, is not

mortally hurt. It is too wild to get in another shot, so a small boat is put out and the game lanced through the heart or lungs with a slender spear. Often the whale will smash the small boat in its death floundering, if the rowers are not agile enough to dodge its great flukes, so only the most skilful men are allowed to finish a wounded whale.

Whales migrate with the seasons. In the early winter they go south, returning north again in the fall.



The harpoon exploded in the lungs of the whale and it died almost without a struggle and sank. The winch will raise the forty-ton body



Cutting up the head of a dead whale after it has been drawn up on the slip at the shore station. The men work with long-handled knives

Something to Put in Your Empty Bottle

GOT any empty bottles? Bottle ships in them. Bottled ships are really quite simple. The masts and other parts that project above the hull may be controlled by strings. The hull itself must be made small enough to slip through the neck of the bottle. Then you mount the masts and attach the cords.

When you are sure that all the cords are working properly, slip the flattened ship through the mouth of the bottle, which should contain some moist putty to serve as a bed for the boat to rest on.

Pull up the strings, glue them to the mouth of the bottle, and then cork it.



Mount the masts so they may be managed by cords; when down, slip the whole through the neck of the bottle

Overcoming Obstacles to Perfect Broiled Hamburger

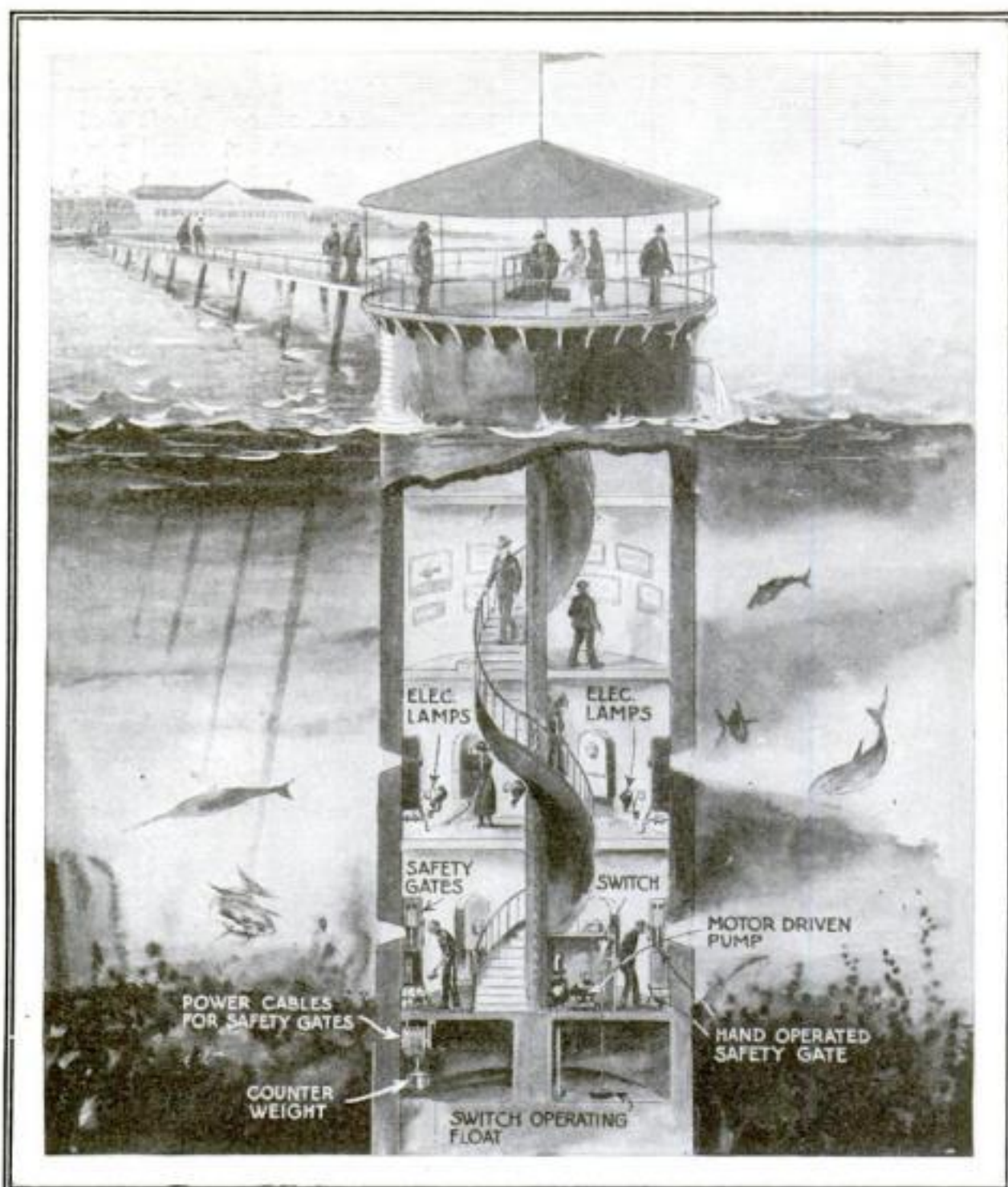
IF Arthur E. Cowan, of Gloucester, Mass., had never eaten broiled chopped meat, one less patent would have crossed the threshold of the Patent Office. It is a broiler so made that, should it stick to the wires, it will prevent broiled hamburger from crumbling to pieces when you try to lift it.

It is made in two sections, held together at one end by rings; the other ends are free to rotate. The wires are bent at one end. You place your hamburger on one section and close the other down over it.

Should the steak stick to the lower one while cooking, swing the upper one all the way round, and the bent wires will gently dislodge the meat, which then slides on to the platter.



Should the meat stick to the lower section, the upper is swung around beneath it, and its bent wires dislodge the meat



For a small consideration, even the poor man may have the pleasure of watching high-priced fish and aristocratic oysters in their natural habitat

Visiting the Fish Without Getting Wet

HOW to observe fish and other sea creatures in their natural environment, without undergoing the dangers and inconveniences of descending in a diving-bell or a diving-suit, has been solved by Edward D. Stodder, of New Rochelle, N. Y.

He proposes to build a pier far enough out over the water so that the wave motion does not disturb the sand on the sea-bottom. At the sea-end of the pier one or more cylindrical structures of steel, cement, or masonry are to be placed. These caissons, which will rest on a firm foundation, are to be high enough to be easily accessible from the platform of the pier through a door in the side of the tower-like caisson.

Around a pillar in the center of the caisson a spiral stairway leads downward below the level of the ocean. Three rows of openings are provided in the submerged part. These openings are funnel-shaped, with the narrow part inside of the caisson and closed by heavy lenses of glass strong enough to resist the pressure of the water.

The uppermost and the lowest rows of openings are for observation purposes, the middle row for the purpose of illuminating the parts of the water visible from the observation windows.

The inventor has provided means for closing the openings in case one or more of the glass lenses should break. The water, rushing through such an opening, automatically starts a mechanism which slides water-tight shutters in front of every one of the openings, and at the same time sets in motion a pump for removing the water which has come in through the broken glass. He has also provided for the closing of all openings by hand power, should the closing mechanism fail to work.

An Electrical Cabinet Designed for the Class-Room

THIS new electric cabinet, containing everything necessary for the study of electricity, looks like a kitchen cabinet. In the first place, there are two shelves that hold nothing but batteries; these batteries are used to supply the current for experiments. Since the voltage is low, danger of shocks and accidents is eliminated.

Then there are several boards that slide into grooves in the cabinet. These are fitted up with various electrical instruments, such as bells, telephones, meters, and push-buttons. The boards may be taken out of their racks and hung up in front of the class, and the pupils can practise on them.



The electric cabinet for teaching electricity contains many boards on which there are several electrical instruments; the pupils wire them up

Fireproofing the Air Mail

YOU want to rush an important document to Washington by air mail, but you are afraid to. Suppose the airplane should catch fire? Your document would be burned, you think.

But you are wrong. Air mail is wrapped in an asbestos cloth container that is fastened to the airplane by thin steel strips and screws. Ten yards of asbestos cloth and ten yards of khaki cloth are used in the container. The asbestos cloth weighs two and one quarter pounds to a square yard.

The Post Office Department tested one of these new fireproof bags at College Park, Md. A sack of dummy mail was enclosed in the bag, and the bag was soaked in gasoline. It was then set on fire and allowed to blaze for twenty minutes.

When the blaze was put out, at the end of that time, it was found that nearly all the letters were intact—the few on the outside being slightly charred.



© Harris & Ewing

Air mail is now enclosed in bags made of asbestos cloth; even should the airplane catch fire, the mail will be safe



A big caldron raised from the heating well by means of jacks placed under the lifting lugs attached to the rim

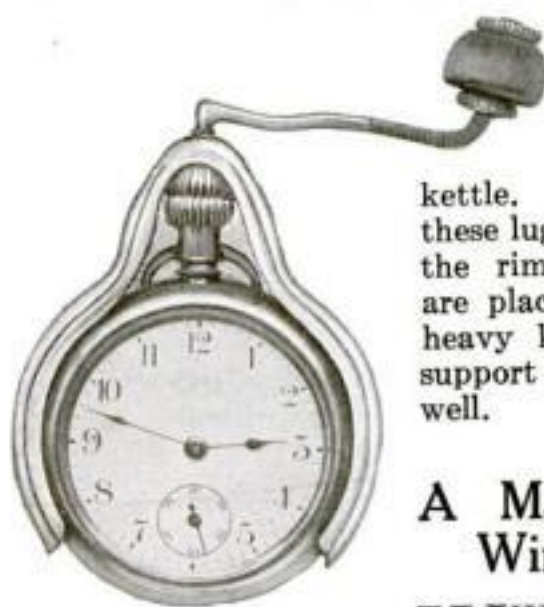
Lifting a Heavy Caldron Without the Help of a Crane

IN the manufacture of caustic—which, in the language of chemistry, may be either sodium or potassium hydroxide—large caldrons of cast iron are used. Many of these caldrons have a diameter of ten feet, a depth of seven feet, and weigh about fifteen tons. Each one of these enormous kettles is placed in a well of fireproof brick and its bottom rests on ball-bearings supported by a pedestal of concrete, centrally placed in the bottom of the well. In the sides of the well are openings communicating with the furnace. The kettle is rotated to prevent uneven heating.

Occasionally it becomes necessary to lift the caldron out of the well. A crane sufficiently strong would cost a great deal. Frank G. Wheeler, of Appleton, Wis., uses detachable lifting lugs of C shape, which fit around

the rim of the caldron and have a bracket at one end which engages the under side of the raised flange of the

kettle. After three or more of these lugs have been clamped to the rim of the caldron, jacks are placed under them and the heavy kettle is lifted from its support and out of the heating well.



This mechanical watch-winder saves many sore fingers in a large repair shop

A Machine Even for Winding Watches

WHEN you wind your watch up at night, you do not feel that you have performed a very strenuous operation; neither have you. But multiply the

operation by twenty, a hundred, two hundred, and you begin to have visions of aching fingers and sore thumbs. This is exactly the way the watch repairer finds it.

To save both time and fingers, an ingenious watchmaker invented the winder, a photograph of which is reproduced above. It is merely a metal clip to hold the watch and a clutch that engages the winding key. Insert the watch in the clip, hold it tightly, turn the handle a few times, and the watch is wound.

Many a repairer has several hundred watches on his racks at a time, and some such device as this is a great convenience and time-saver.

Turn on the Gas Like Electricity

YOU light a match, turn on the gas—and the match goes out. Then you turn off the gas, look for another match, and start all over again. Ah, but there is an automatic gas-lighter, invented by Edward Obermeyer of Nessen City, Mich.

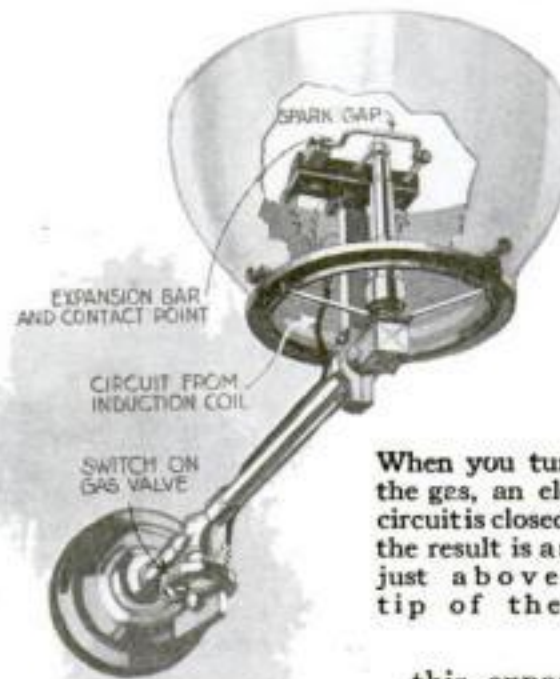
It is so constructed that an electric spark jumps across the tip of the gas-jet every time the gas is turned on. Furthermore, if the gas should be blown out accidentally the spark will reappear and ignite the escaping gas. The gas-cock has a bar within it that is part of an electric circuit. When the valve is closed the bar does not touch a contact point near it and the circuit is broken. But when the cock is turned and the valve opened the two contact

points touch each other and the circuit closes. A current is induced into a second circuit, whose contact points are spaced a short distance apart directly above the tip of the jet. This current is strong enough to cause a spark to jump across the gap and light the gas.

Once the gas is lit, the heat from the flame will expand the arm that furnishes one of the contact points of the spark, and

When you turn on the gas, an electric circuit is closed, and the result is a spark just above the tip of the jet

this expansion breaks the primary circuit and does away with the spark.



In Case of Emergency Use the Wayside Telephone

YOU start to skid, lose control of your car, and crash head-on into another car! You are miles from the nearest town—what's to be done? In a case like this a "wayside telephone" is a godsend. All you need is a key to the telephone box. These boxes are painted red and white and are located a mile apart on the road along the Mohawk river in New York State. In case of accident of any kind, you walk to the nearest one, and open it. Inside you will find a telephone and a list of the nearest doctors, garages, hospitals, and hotels, with their telephone numbers.



The car hit a fence, and the driver was hurt. The nearest town was some distance away, but a "wayside telephone" was handy and one of the men unlocked it. Besides the telephone, there is an emergency directory, containing the names of the nearest doctors, garages, and hotels, with their telephone numbers.



As the cylindrical tank is rotated, molten iron pours from nozzles into molds; two men handle it easily

Making It Easy to Handle Molten Metal

LADLING molten iron by bucket requires plenty of help and much care. A Cleveland foundryman has invented an efficient ladling-machine that can be worked by two men.

A cylindrical tank mounted on wheels that run in tracks is filled with molten iron. One man moves the tank until it is directly over troughs that lead to the molds. Then the other man turns a handle and the tank revolves. Two nozzles discharge the iron into the troughs every time the cylinder is rotated. The tank is then rolled onto the next set.

The tank is made of heavy boiler-plate lined with fire-brick.



These five pieces of type, bearing strange Oriental characters, were used in Korea in the year 1403

Five Centuries Old Type

BACK in the beginning of the fifteenth century, the Korean printer sat cross-legged in front of a "form" and "pulled proofs." And even in that far-off day he used metal type not so very different from the type used now. The strange Oriental characters stood out from the upper surface of each piece of type, and the lower surface was curved so that it would cling firmly to the bed of beeswax into which it was sunk. The printer inked the type, laid the paper on it, and gently brushed the paper with a piece of felt. Thus he pulled proofs at the rate of fifteen hundred a day.

Fifty pieces of this type are now in the American Museum of Natural History, New York, and fifty more are in a museum in England.

Why Small Models Won't Work When Enlarged

The Patent Office abandoned them long ago

By C. A. Briggs

MANY years ago the Patent Office abandoned the practice of requiring working models when issuing patents. This was done in the face of increasing complexities in the devices presented for patenting. Now patents are issued on the basis of drawings and descriptions, except in special cases.

It was found that models were often more misleading than instructive. The full-sized model may prove impractical even when the small one seems to work perfectly; and the reverse may be true—a large design may give results to an extent that was not indicated at all in the small model.

Probably no better device for illustrating the achievements and perfection of modern design could be found than the typewriter of the present day; yet the same arrangement when made on a large scale will serve to illustrate just what a design should not be. A fourteen-ton typewriter was built for the San Francisco Exposition by a typewriter company. When this large typewriter was operated, the arm carrying the type on the end moved ponderously up and struck with a *pung*. It then fell back with a *clank*, and bounced two or three times before coming to rest. These arms were so

heavy that a special engine had to be installed in the foundation below the typewriter to operate the parts.

The spring that caused the carriage to move was a relatively weak one. If this spring had been made to scale, its use would soon have wrecked the machine. On the ordinary sized typewriter of this design a speed of one hundred and seventy words a minute has been obtained by the best experts. The huge model was capable of about thirty letters a minute.

There are certain relations between the strength, weight, inertia, size,

time of action, and deflection that dominate design; and good design is always consistent in this respect.

Some time ago the writer was shown a toy engine. The parts comprised a flywheel, a crank, a piston, a cylinder with an opening at one side near the closed end, and a valve consisting of a piece of thin sheet-iron that could be moved back and forth across the opening by means of a rod engaging a cam mounted on the axis of the flywheel. Just in front of the valve opening there was a tin lamp with a wick for burning alcohol.

When the engine was started the piston moved away from the opening and thus sucked in the hot alcohol flame. Just before the end of the stroke was reached the valve would close the opening, and the cooling of the hot gases would then create a partial vacuum. The result was that the piston was jerked back. The power and speed of this little engine was surprising. When going well it would simply roar. The behavior of the engine was so striking that it occurred to almost everybody, on seeing it run, that it would be desirable to make a large engine on the same principle.

However, one thing on which the action of the engine depended was the very rapid cool-

ing of the hot vapors and gases when they were shut up in the cylinder. Now, as the size increases, the quickness with which the gas cools falls off very rapidly; and if a large design were made the experimenter would find his attempt a failure.

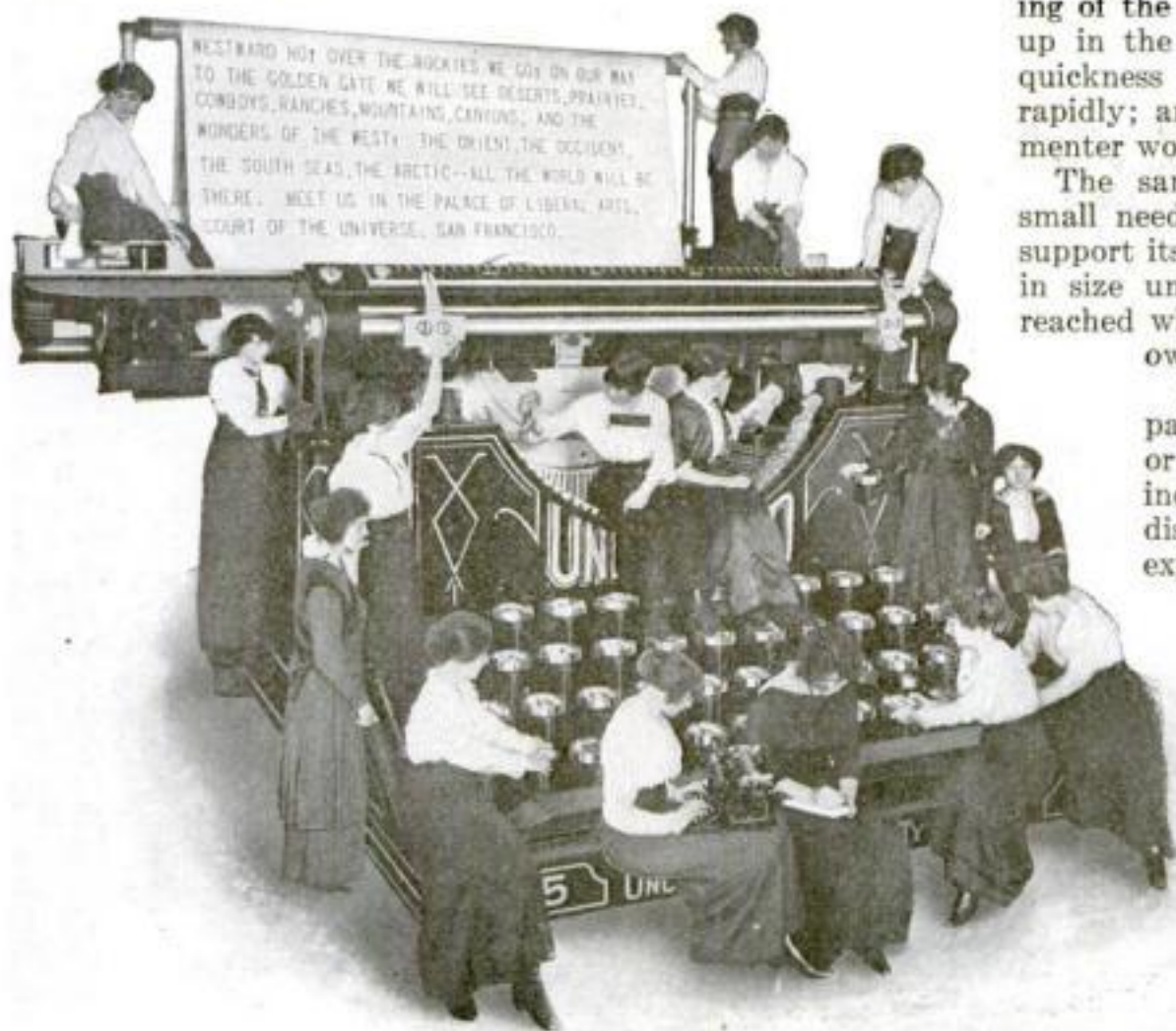
The same thing applies to electrical devices. A small needle can easily be magnetized so that it will support its own weight. When the needle is increased in size until it becomes a bar, the point is soon reached where the bar will not be able to support its own weight.

In electrical machinery the heating of the parts is often the limiting factor in the capacity or use of a device. The heating tends to increase with the volume, and the ability to dispose of this heat increases as the surface is exposed. The volume increases as the cube of the dimensions, and the surface as the square of the dimensions. It is therefore necessary in the larger sizes of machines to alter the design to provide, among other things, the necessary arrangement for getting rid of the heat.

This fourteen-ton typewriter is an exact enlargement of one of the present well known machines. Its operation is difficult and slow. Small models often fail to work after they have been enlarged



This tiny engine is a speed demon; the piston is shot backward and forward by the rapid heating and cooling of the cylinder—the heat being produced by an alcohol flame and the cooling by the shutting of an automatic valve. But would this hold good for a large engine? That is a question

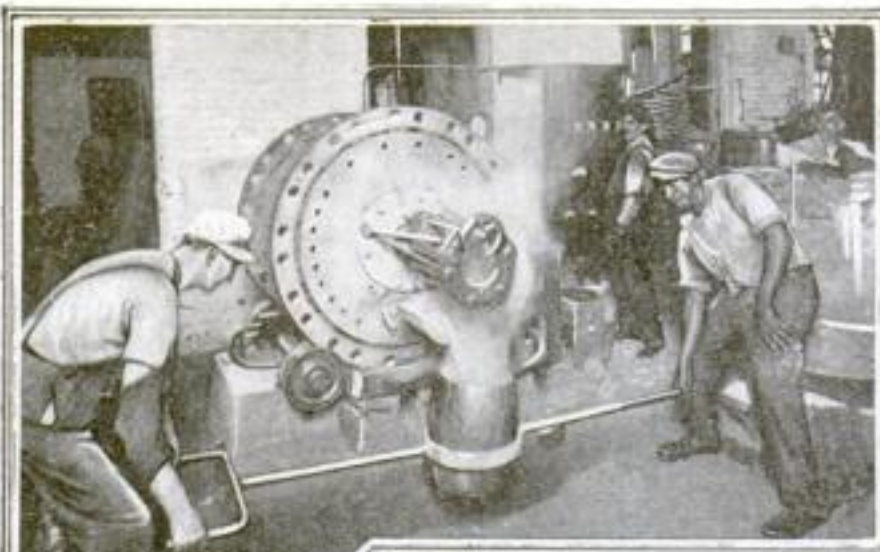


A Grip for the Rivet

RAT-TAT-TAT! The sound of riveting drowns everything else; and the riveter must listen to it all day long while he tightly grasps the vibrating hammer. A hard life, to be sure.

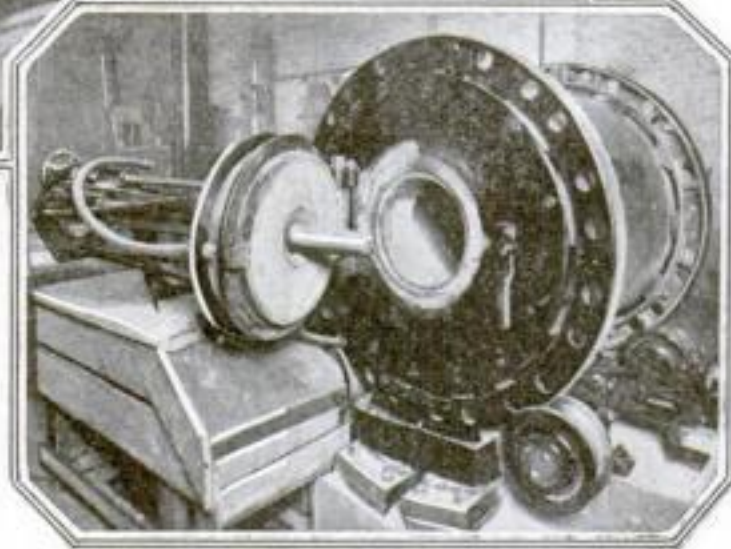
But a grip has been invented that will make his work much easier. It fits over the business end of the hammer and provides a sure grip. The riveter simply grasps a projecting handle in order to guide the hammer to the work.

The grip is made of steel and can be used on chipping or calking hammers. It adapts itself to either right- or left-hand riveting, and is particularly helpful for overhead riveting.



The molten brass is being poured from the electric furnace; the man at the switchboard controls the flow

This is an electric furnace; the electrode that heats the metals is seen protruding from inside of the door



Making Brass in an Electric Furnace

A NEW electric furnace for melting copper and zinc to make brass has recently appeared. Hitherto it has been possible to melt these metals and alloys only in crucibles.

The electric furnace is rotated by rollers and moves in two cylindrical tracks. The rollers are driven by a motor at the proper speed to make the furnace rotate at the rate of two revolutions a minute. The electrodes for melting the metal are heated by a current that comes through short pieces of flexible cable that connect with the track; and the current is supplied to the track by means of shoes which press against it.

On small furnaces electrodes are operated by hand, but on the larger furnaces automatic electrode control is used. In the small furnaces the door is in one end only, but in the larger furnaces both ends are provided with doors. In the lower of the two pictures above you can see the latch that holds the door shut when the furnace is charged, and also the electrode projecting through the door. The contact shoes are shown pressing against the track.

The cable that supplies the power to the furnace comes from conduits in the floor. The operator regulates the flow of the current by means of a hand-wheel. The upper picture shows the metal being poured from the furnace. The operator at the switchboard is controlling the furnace by means of push-buttons. The two men in front are holding the bucket.

Probably the most important of all factors in reliable and efficient furnace operation is the furnace lining. Especially is this true with the melting of non-ferrous metals, where a lining with many joints will have a decided tendency to absorb metal. In order to overcome this difficulty the lining should have as few joints as possible.

In this furnace the electrode supports at each end of the shell are made in one piece, and they may be removed simply by unbolting them from the end plates. The shell can be lifted off the rollers by a suitable hoist or crane, just as if it were a barrel, and turned on end. Thus the end plate of the furnace can be unbolted and removed from the shell.

The door of the furnace is made of one solid piece of brick, with a hole in the center through which the electrode projects.



A grip has been invented that fits over the muzzle end of a riveting hammer and has a projecting handle that the riveter grasps; his work is thus made much easier



It adapts itself to either right- or left-hand riveting and is particularly adaptable to overhead work

A New Reason for a Clean Face

DID you ever have to start on business to a distant city on a few minutes' notice, with just time to buy your railroad ticket, a toothbrush, and a clean collar? Perhaps that is what was in Charles E. Gronbeck's mind when he invented a vest-pocket edition of the safety razor.

The new razor consists simply of a light frame to take the blade. The lower edge of the frame is provided with the familiar serrated edge to smooth down the cheek and bring up the bristles for slaughter, while an extension of the frame provides a firm grip for the thumb and first finger of the shaver. The inventor points out that his device is self-contained, and that a closer grip is had than is possible with a long-handled razor.



© Press Illustrating Service

So small is this safety razor that you can carry your own barber-shop in your vest pocket

Around the World in a Minute

YOU can cross the Atlantic ocean in three seconds! Leap over a volcano in one bound! Race from the North to the South Pole in half a minute! That is, if you visit the miniature Earth built in Boy Land, Santa Barbara, Cal. The Earth is laid out flat, map fashion, and covers about two acres of ground. The continents, rivers, lakes, and oceans are exact small reproductions of those on the Earth. Every wrinkle, mountain, and valley is in perfect proportion. The waters of the Earth are there, too—the Atlantic being about three feet deep.

Boy Land is a school founded by Prince Hopkins; the building of the Earth is his way of teaching geography to his pupils. Mr. Hopkins, who is going to start another Boy Land school at Stamford, Conn., tells us the following:

"When I started my school in Santa Barbara I had a dike built across a little valley. I then said to the boys: 'The pool of water formed by this little dike will represent the Atlantic ocean. We will take a Mercator's map of the world to show us how we should dig the shore lines to make them resemble the shores of America and of Europe. Then we can build boats to sail across, like big steamers that cross the ocean.' We took a map down, and drove stakes into the ground from which to stretch strings from north to south or from east and west, to represent lines of latitude and longitude.

"Next we marked the contours of shore lines by means of a tennis-court marker, and we dug earth from the ocean and lakes to pile up into the mountain ridges. To make this physical labor more exciting, I had a little dredger boat made for them. On its arrival, the boys inspected this boat with great interest. We floated it in the ocean above the dike. A gasoline engine inside, which one boy could operate, ran a little chain of buckets.

"The mechanical efficiency of this machine was low, but its psychological efficiency was high, since digging became much more interesting when carried on to the music of the little dredger chug-chugging near by.

"This dredger engine-boat demanded great attention

at the time of the opening of the canals, the boys themselves putting in the Suez and Panama canals.

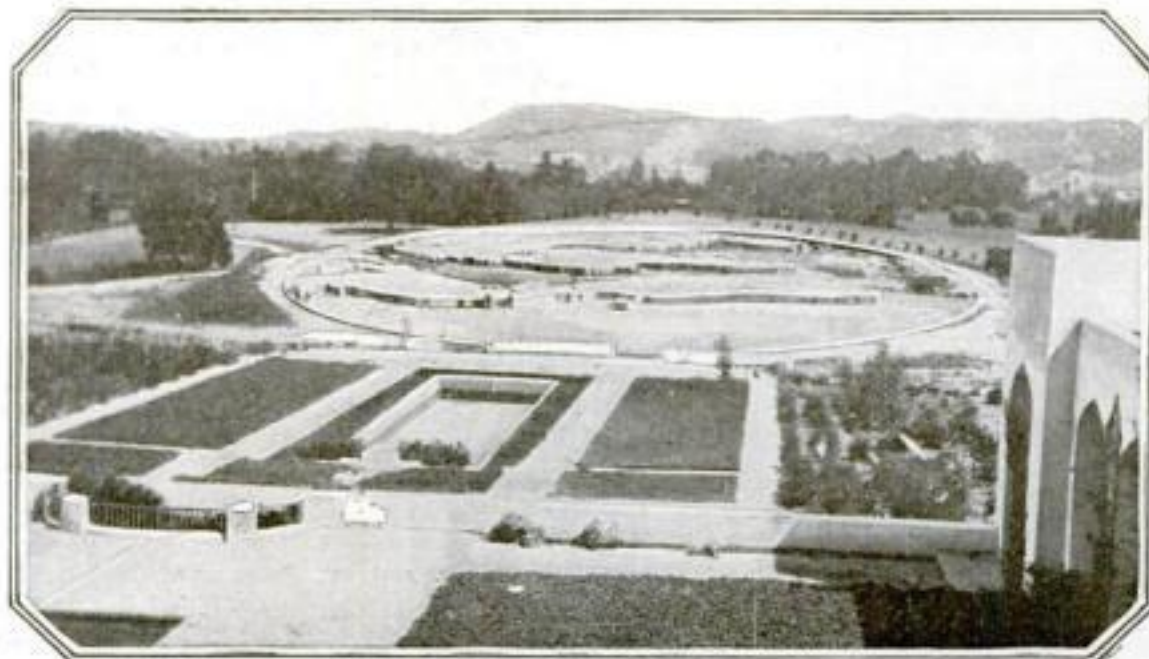
"A railroad system will connect the series of small cottages at one end of Boy Land with the main cottage at the other end. It will be used not merely as a toy, but as a valuable means of transportation. Things obtainable at the larger building, such as linen for beds and baths, will be taken over on the train, and likewise vegetables, wood, etc., will be taken to the main building.

"At Boy Land we sometimes take our history books out on the huge open-air map of the world and there dramatize various events at what corresponds to the very spot where the real life-drama was originally enacted. The main purpose of the map is, of course, to visualize geography. It's large enough so that the boy himself can paddle through the world's chief waterways; and the railroad lines of the various nations are presented in miniature. The boys have, of course, built the ranges of mountains in relief, and have here and there represented agricultural products of the different countries.

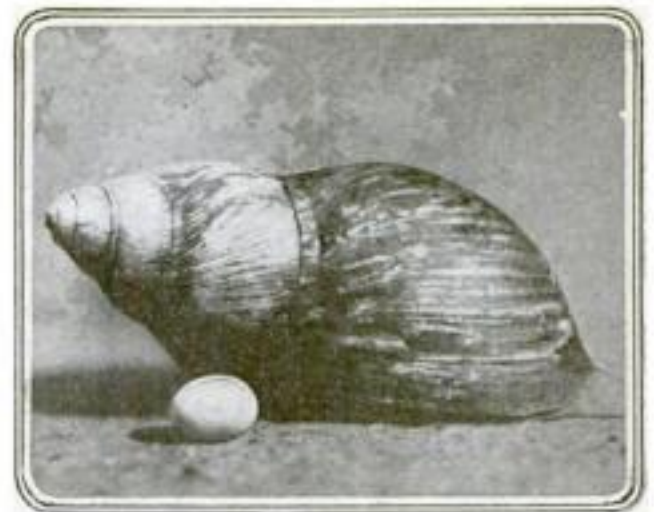
"While the map was still in construction a lively commerce sprang up. Little ships traveled along the main waterways, and we began to lay the main trunk railways of the world with toy railroad tracks."



The Pacific Coast is getting its final touches; next the ocean will be poured in



Behold the Earth! It is reduced to two acres and is laid out flat, but the waters and continents are all in proportion



The snail is eight inches long, and came originally from East Africa

A Giant Snail and Her Egg Side by Side

ONE of London's foremost Zoos is very much excited—it has added to its collection some giants. They are snails, and many of them measure as much as eight inches. If you picked one up it would just about fit in your hand.

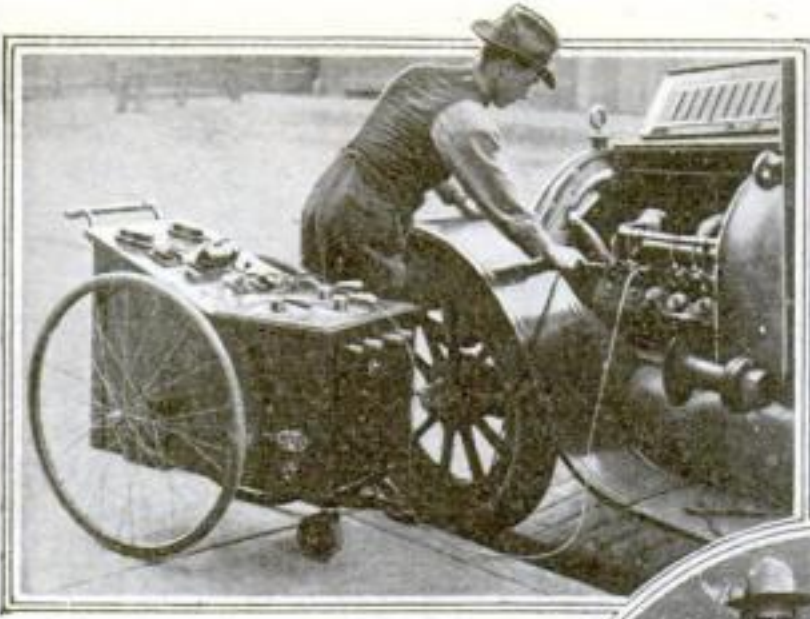
These snails came from East Africa; had they remained there much longer they probably would have been eaten by the natives. Both the snail and its egg are considered delicacies in that far-off land.

The egg of this snail is so large that it is often mistaken for a pigeon's egg. A picture of a mother snail and her egg side by side is shown in the picture above.

Cultivating Cooties for Scientific Reasons

AN incubator for cooties! Service men might think this superfluous trouble, when so many of the cooties could be freely obtained from the foreign camps during the war. But to study the pest scientifically an incubator for rearing them was required, the investigators devising an arrangement for bringing up great numbers of the lice. The cooties had to be fed, and human blood is their food, so volunteers sacrificed themselves for the cause. As many as four thousand were fed at one time on the forearm of one person.

Since it has been found that the germs of several diseases are carried by the cootie, Serbia typhus fever being one of them, the need of incubator methods for enabling scientific study to eradicate the evil is apparent.



The electrical test-cart is the first thing of its kind in the way of a complete apparatus for testing any part of the electrical mechanism of automobiles, trucks, and tractors



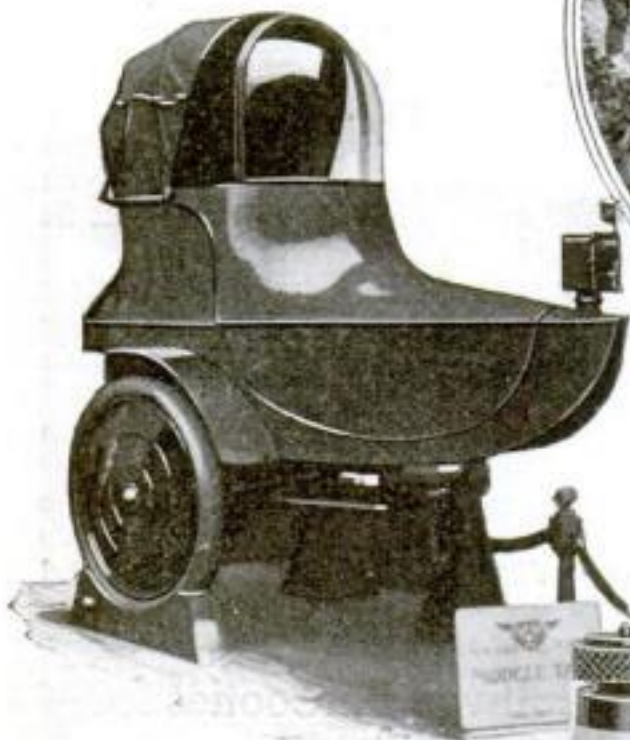
When the government laid up all private cars, a railroad president wanted something to take him over the company's road. His automobile makes sixty miles an hour upon the rails



Operated in small spaces this baby tractor was adopted by the government for work in camp gardens. It plows or cultivates, runs a washing machine, pumps water, in fact does a variety of odd jobs

Things New in the

Here are a few suggestions
comfort: choose the ones



One of the most curious exhibits shown in the recent Paris automobile show was a side-car for use on a motorcycle and serving as a side-car taxi-cab

The rough-surfaced balls move up and down by piston pressure, keeping the spark-plug clean



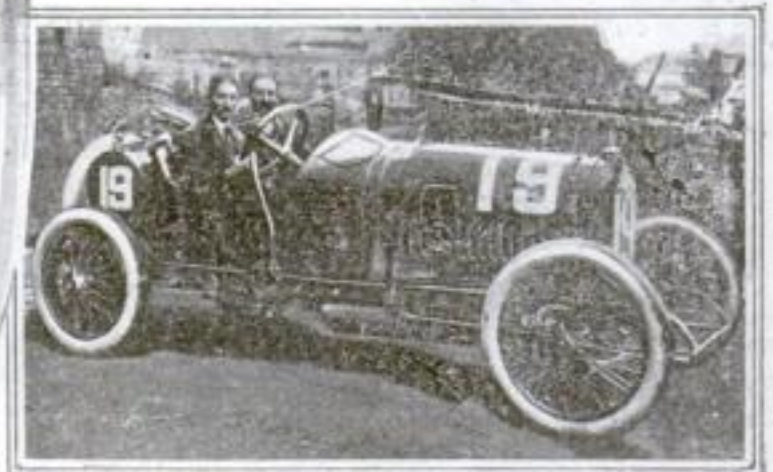
© International Film Service Co.
"A whale of an automobile," you say. You're right, too. A manufacturer took this means to advertise a certain product. Jonshpeers from between the whale's jaws



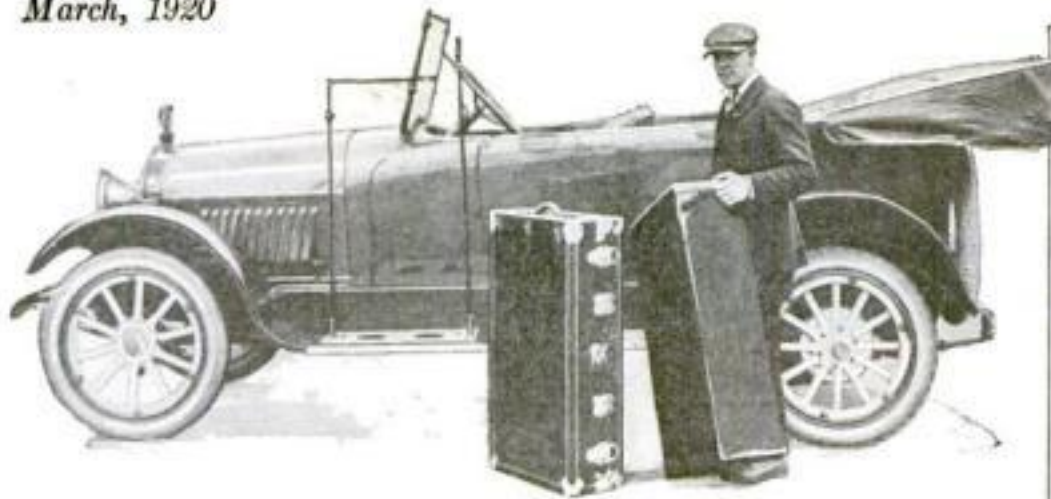
Here is a truck body made from gas-piping. The rear doors are also of pipes, which slide into each other when opened. The novelty of the scheme should appeal to truck-owners



These metal pads encircle the tires and prevent slipping without the usual unpleasant bumping. The holes in the pads increase the traction



Covered with racing laurels, this aged car came from France to hang up new records for the year 1920. Incidentally it made a fine showing here last year



The slidable trunk-holder includes springs which support the trunk so that its contents are not shaken even when the car travels over rough roads



If the windows in your rain curtains tear or break, you can easily purchase others and apply them in a few minutes in the manner shown here



With this simple tool, made of the best cutting steel with a self-centering projection below the cutting edge of the reamer, valve seats may be ground easily, quickly, and cheaply

World of Motors

for your convenience and best suited to your needs



An electric crane swings a ladle before the mouth of the furnace and the clay stopper is removed. The bucket of molten metal is carried to the molds. Thus the automobile cylinder block is made

Instead of a tool-box on the running-board, the 1920 car has a tool compartment in one of the front doors. The flap of the compartment can be locked

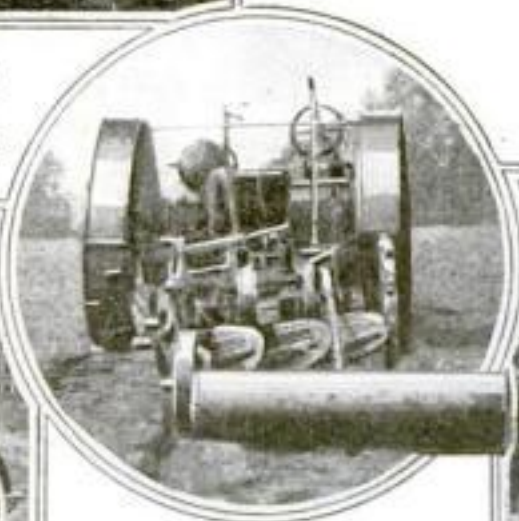


Easily transformable into either an ambulance or a limousine, this novel automobile serves a twofold purpose for its renting owner



© International Film Service Co.

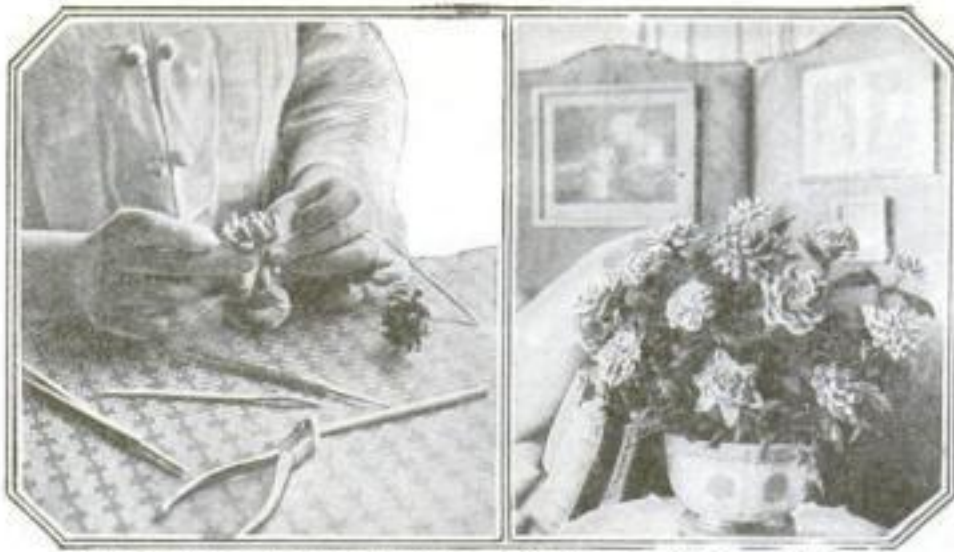
With a suitcase strapped on behind the little red wagon, a week-end can be pleasantly spent, especially if the owner is within a few hours of duck country



A heavy roller, having a long arm by which it is attached to the plow frame drawn by a tractor, utilizes a roller much heavier than the ordinary one. The rolling and plowing can now be accomplished in one operation



Prohibition has not yet reached Bombay, India; nevertheless a wine-cask serves as a water container for street sprinkling. The cask is mounted upon a motor-truck. Formerly ox-carts were used



Here is a bread-dough flower in the making; Madame Gatticker does most of the shaping with her hands, but she also uses pincers and scalpels

These realistic artificial flowers were made from bread dough, taken from the heart of hot fresh bread and kneaded into shape

Bread Flowers for Sale Here

DON'T eat fresh hot bread—it's indigestible. If you doubt this, take a piece in your hand and squeeze it. When you open your hand you will have a soggy, heavy lump of dough in it. Madame Prosper Gatticker, of Paris, did this once, and she kept right on squeezing and shaping it until she had in her hand a perfect imitation of a rose. She hardened it in front of the fire and painted it red. And so she began making artificial flowers out of bread dough. She sold them, and turned the money over to the poor.

You see, Madame Gatticker is one of the idle rich, and she does this work partly to fill up the time and also to interest her friends in philanthropic work. During the war she sent packages to many lonely soldiers, and was known as *La Marraïne Mystérieuse*—the mysterious godmother.



Photographs © Ledger Photo Service

This non-sinkable sailboat made of aluminum was built in Germany

Of course an aluminum boat capsizes easily; but the hatches close automatically as the boat goes over, and after it settles the people within open one of the upper hatches and call for help.

A Sailboat that Can't Sink

BELOW you see a German inventor in his aluminum boat. Aluminum is light enough to make a fast sailing-craft, but this very lightness tends to cause the boat to capsize.

In that case, what happens to the passengers? They are perfectly safe: the hatches close automatically over the heads of the people as the boat goes over. The water forces the lower two shut and gravity drops the upper ones.

After the boat has settled on its side, the inmates open one of the upper hatches and shout for help.



This Clock Calls Nurse and Medicine

CLANG! The clock strikes one. A little door above the face flies open.

To let the cookoo out? No; the medicine bottle. You see, the clock is part of a medicine chest for use in hospitals.

The striking of the clock summons the nurse, and when she arrives she finds before her the open door. Inside it there is a small revolving table on which are placed the different medicines that she is to give to her patients at that hour.

Within the chest there are several small revolving tables, one for every hour of the day. Each table is marked with its particular hour. Every morning the nurse puts on the one-o'clock table the medicines that should be given to her patients at one o'clock. She does the same thing for every other hour in the day, and then goes away and forgets all about the bottles until she is sum-

moned by the striking of the watchful clock.

The clock goes round, and as each hour strikes, its corresponding table moves into place in front of the medicine-chest door.

The nurse, on arriving, simply lifts the bottles of medicine from the revolving table and gives each patient his particular dose.



When the clock strikes, a door flies open and a bottle of medicine stands behind it on a revolving table; there is a table for each hour of the day

A Train Helps Out an Airplane

PILOT P. W. Smith was ready to hop off on his daily letter-carrying trip to Chicago, and he went to the shed to get some water for his engine. Alas, he found there was none; the pipes had frozen overnight.

As he stood pondering, the toot of a train whistle sounded in the distance, and in a few minutes a train passed within a hundred feet of the hangar. As it approached the pilot flagged it and told the engineer his troubles.

"Glad to help you out," said the obliging engineer of the train.

The passengers, accustomed to delays, didn't mind this one. Two fifty-gallon tanks, which had held gasoline, were rolled up the railroad embankment and filled with hot water fresh from the boiler.

In a very short time the airplane had started, and the letters it carried arrived on time.

Cleaning Out the Hornets' Nest

WHEN hornets build their nest outside your window, clean them out with a vacuum cleaner, says Mr. A. E. Gardner, of Philadelphia.

"I attached a piece of piping to my vacuum cleaner," says he, "and held the end up under the opening of the hornets' nest; then I turned on the power. Hundreds of hornets poured forth and were promptly sucked down the pipe."

"Later I carefully opened the bag of the cleaner, fearful lest there were some still alive. But they were all dead."



Don't argue with a hornet or you'll be stung. If you wish to empty a hornets' nest get out your vacuum cleaner and simply suck the hornets into the bag

Tanks in the Sight-Seeing Business

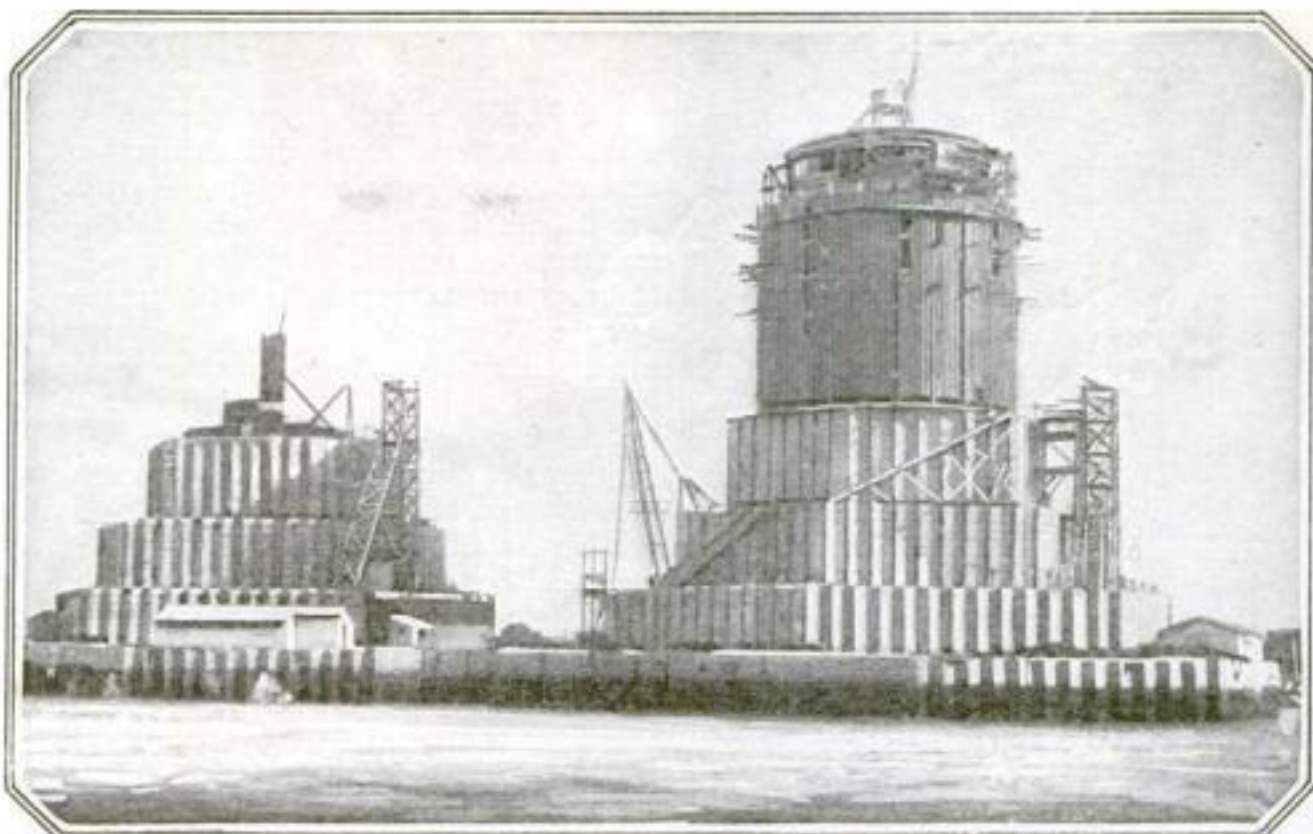
MOUNTAIN climbing is hard work for most people, but easy work for tanks; consequently, many of the French war tanks that are now idle are being made over into sight-seeing buses for use on Alpine mountain roads.

At the right you see a Peugeot tank that has been made over to accommodate ten passengers. While the tank slowly crawls along, the people sitting on top of it can give all their attention to the wonderful scenery about them.

A tank, as you know, can successfully climb over almost any obstacle, and will move calmly onward from a most perilous angle.



War tanks are being turned into sight-seeing buses in France; this one will accommodate ten people, and makes regular trips up the mountain roads in the French Alps



Concrete towers go out after a sunken ship and, with the aid of the tide, are able to drag it inshore; where the tide is not great enough the towers are filled with water and sunk to the depth of the ship

Raising Sunken Ships with Hollow Towers

"A SECOND tower of Babel!" murmured the wondering townfolk of Southwick, on the coast of England, as they watched the erection of a curious tower-like structure on the beach. The tower was hexagonal in shape. There were four stories, each one sixteen feet high, and the stories receded gradually. On top of all was a great tower. When it was half finished another one was started.

The towers turned out to be great salvage ships, built by the English government for use in raising vessels that were torpedoed in the war. They are so constructed that they can dig up ships that have

sunk in water deeper than twenty fathoms.

Each story is made up of hollow concrete boxes four feet square and two feet wide. They are fastened together by steel cables. Thus the whole structure is very strong, and yet light enough to float in fifteen feet of water. Now for the action!

Two of these floating towers are sent out to salvage a ship. Suppose the ship is in fairly shallow water. The towers are towed out and stationed one on each side of the wreck. Divers pass steel hawsers from the towers under the wreck, and make sure that it is held fast.

When the tide is lowest, the hawsers are tightened. As the tide rises, the buoyancy of the towers raises the wreck from the bottom. The whole outfit is then towed inland until the wreck hits bottom. At low tide the hawsers are tightened, and the process is repeated until the wreck is near enough to shore to be patched.

In places where there is not enough tide, water is pumped into the towers and they sink. When the wreck is properly roped, the water is pumped out again. And as the towers rise they take the wreck with them. Old hulks have often been used for this kind of salvage work, but this is the first time that concrete ships have been specially built primarily for the purpose of salvaging.

Packing the Farmer's Fruit



The force and speed of the vibrator can easily be changed by a device that gives twelve gradations of power

How to Cut Down Your Electric Light Bills

EVERY user of electric light has it in his power to cut down his electric light bills by avoiding waste as much as possible. The most radical way of practising economy in the use of light consists in turning off the current when the light is not needed. But often, while the full intensity of the light is not required, there must be some light. For several years there have been in the market electric lamp sockets that make it possible to obtain from two to five gradations of light by setting a switch increasing or diminishing the resistance of the rheostat in the socket.

Recently a new light-regulating socket has been invented with which twelve gradations of light may be obtained by the mere pulling of chains operating the switch of the rheostat. The gradations range from the full light obtainable from a forty-watt lamp to a faint glow of the filament when the current is reduced to five watts.

The Drum that Wears a Wound Stripe

THEY were gathering in the wounded after one of the battles at Verdun, when they came across a drum that had been shot through the head. It was taken to the hospital and given a new one. In a short time it was back at the front, in active service again.

Now that the war is over, the drum has been ordered back to the Marine Corps camp at Quantico, Va. The regiment decided to present it with wound and service stripes—but a drum has no sleeves to wear them on. So the four service stripes were attached to one side of its head, and one wound stripe was placed on the other side.

APPLES, pears, and other hardy fruit, beets, carrots, cabbages, and other products of the truck-farm, are usually shipped in barrels. Packing fruit in barrels so that it is not injured in transportation requires some skill and experience, but the most difficult part of the packing operation is closing the packed barrel by placing its head in position and fastening it down.

An apparatus recently patented greatly facilitates this closing operation. It consists of a base shaped to receive the bottom of the barrel, two tiltable posts which support the framework of the closing mechanism,



After the barrel has been placed in position on the base of the machine, the downward motion of a lever will press the head of the barrel home into its groove

and the lever arrangement by which the head of the barrel is forced down and into the groove provided for it. The barrel to be headed is placed in its proper position on the base, while the posts are in a tilted position, facilitating the placing of the barrel in position. Then the posts are brought to a vertical position, the barrel head is placed on top of the barrel underneath the disk of the closing mechanism, and the lever is pressed down, forcing the barrel head into its groove.

The disk pressing against the barrel head is held in a horizontal position by a cross-frame guided in its up-and-down movements by tubular guide-rods which slide within the two tubular posts supporting the closing mechanism.



By raising the seat, the teacher can sit in her pupil's place; the pedestal takes up little room

Advocating Pedestals for Students

EVEN if you don't put your child on a pedestal, his school-teacher probably will—for the new pedestal school-room seat is becoming increasingly popular. One child's seat and the desk of the child behind him are mounted on a pedestal, so that either one or both of them may be easily removed.

The pedestal takes up much less room than the usual spreading leg support with its complicated framework. The height of both desk and seat on the pedestal can be adjusted to suit the pupil, and the seat is mounted swivel fashion, so that he may swing it slightly from side to side.



Shot through the head at Verdun, this drum now wears a wound stripe, together with four service stripes; someone has also presented it with a Croix de Guerre

Jumping the Dams with Your Ship

A boat-lifting mechanism that would open waterways now closed

A MECHANICAL fish that can jump a dam is the idea of Johann Jargen Richard Haalek, who emigrated from Stelle, Germany, to this country about ten years ago. Many tributary streams would teem with life but for the spots along their course where canals or expensive systems of locks would have to be built.

The new idea would do away with such difficulties. Only a system of dams needs to be constructed, each dam being furnished with the mechanical contrivance for lifting boat, cargo and all, over the obstruction. Standardized forms of river boats would be used.

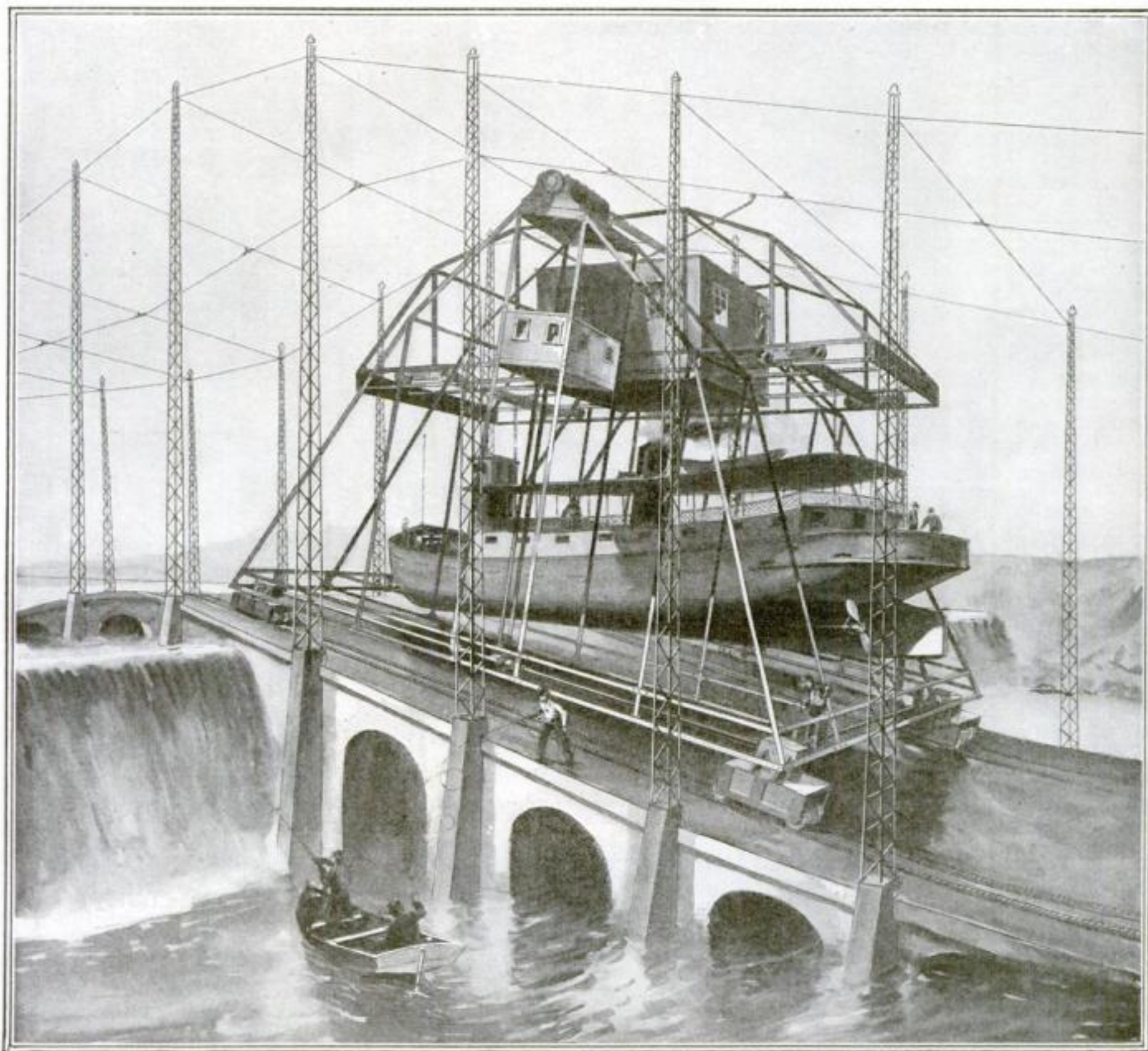
The boat-lifting mechanism is a

structural steel framework composed of two triangular-shaped side members joined at the top by a horizontal transverse pivot-shaft; on this is mounted a bridge-like cradle. The two sides are made rigid by transverse girders, which also provide for mounting the whole upon four four-wheeled trucks running on a track laid on the bottom of the river and extending up over the dam.

The boat is hung from the overhead pivot-shaft by two bridge-like members that are suitably tied together by cross-girders and provided with a longitudinal track on which run two small carriages with pulleys over which the boat-lifting cables extend

downward from the drums in the house mounted midway between the bridge members.

In operation the boat is first floated between the side members and under the lifting platform. Then the small carriages on the lifting platform are moved back or forth until the ropes drop perpendicularly, when they are connected with the special cables attached near each end of the boat. This done, the boat with its cargo is lifted by electrical power bodily out of the water. The framework is set in motion, the gear wheels toothed in the track so they cannot slip. Freedom to swing permits the platform to hold the boat in a horizontal position.



The mechanical arrangement for lifting vessels over obstructions in otherwise navigable streams: the boat, cargo and all, is bodily lifted out of the water and transported over the obstruction



Put Out of the Race by a Pirate of the Air

ATTACKED by a winged pirate, Lieutenant Etienne Poulet, competing in the recent air race from Paris to Australia, had a narrow escape from death while flying above the mountains on the Siam-Burma border. Bad weather had forced the French aviator to proceed at low speed, low for an airplane, and he was flying at an altitude of 1,000 feet above the mountain chain about 100 miles east of Maulmain in Lower Burma, when a huge vulture dropped from the clouds. After circling the machine as if maneuvering for position, the great bird hurled itself at the airplane. There was a crash, a cloud of feathers, and the vulture's body dropped earthward.

But, although victorious in the strange combat, the airplane was badly crippled. The vulture had charged directly into the right propeller. The resulting shock was more than the blades could bear. When it is recalled that in the American trans-continental race one machine was forced down because in a heavy rain-storm the propeller blades were worn away merely by contact with the drops, it is easy to understand the shattering effect of the impact of the huge bird's body. Poulet made the best landing he could in a jumble of mountain peaks. For days he was given up as lost, but he finally succeeded in repairing his machine, and limped into Maulmain—put out of the race by a bird.

The Gum that Gertie Chews

She can still get it for five cents in spite of the increased cost of manufacture

Photographs © International Film Service



Does Gertie, as she rhythmically works her jaw, ever think of the life of the chicle she chews? It came first from a tree like this. A native boy is shown here cutting intersecting spiral grooves in the bark of the tree; the sap runs down into a bag at the base of the tree. He has been particularly busy since Nellie M. Horton, of Cleveland, Ohio, invented pepsin gum nineteen years ago



You've seen Gertie stretch her gum; but, as you see here, a native stretched it long before it came to her. The stretching is part of the cooking operation. Several bags of chicle are dumped into a large tub placed over a fire. As the water evaporates, the gum is stirred and then stretched to test its concentration



The thin slabs of gum are cut on this table. How Gertie must envy these girls their jobs! As for the oil-cans on the shelf, we must admit we're puzzled. Surely chewing gum is soft enough to need no lubrication other than that which the user gives it

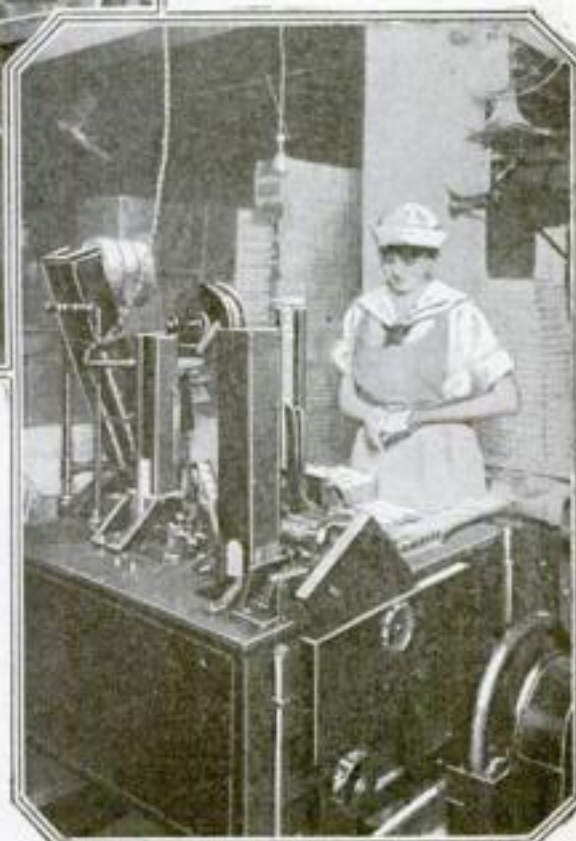


The gum is cut into cakes that weigh twenty-five pounds each, and is shipped from its native land, South America, to factories in its adopted country, the United States. The chewing-gum industry in this country is capitalized at over seventy-five million dollars, and there are at least seventy-five million gum-chewers



The cakes are sliced, flavored, kneaded, and rolled until they are quite thin; then they are run through a thinning-machine. The kneaders dress themselves up like bakers, and the inside of the gum factory looks much like a bakery

Slices of gum are dropped down the square column in the foreground. The machinery rattles, groans, moves in and out, and soon finished bundles of gum trickle out of a door below. Each slice is wrapped separately, and there are five slices to a package—all for a nickel!

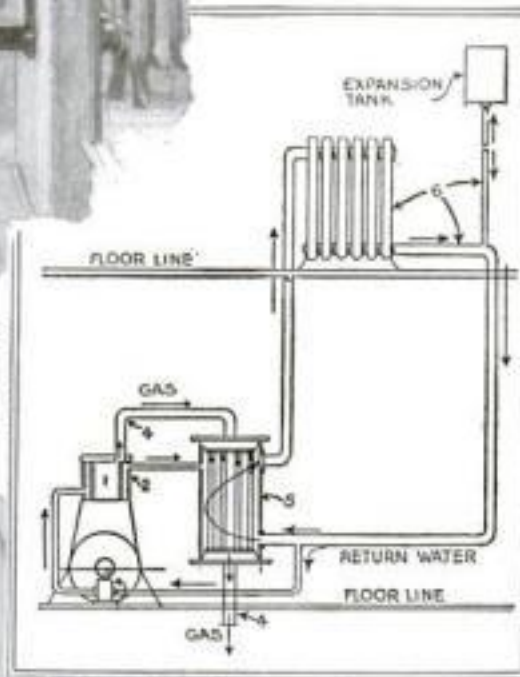


A Few of the Many Done with the Exhaust

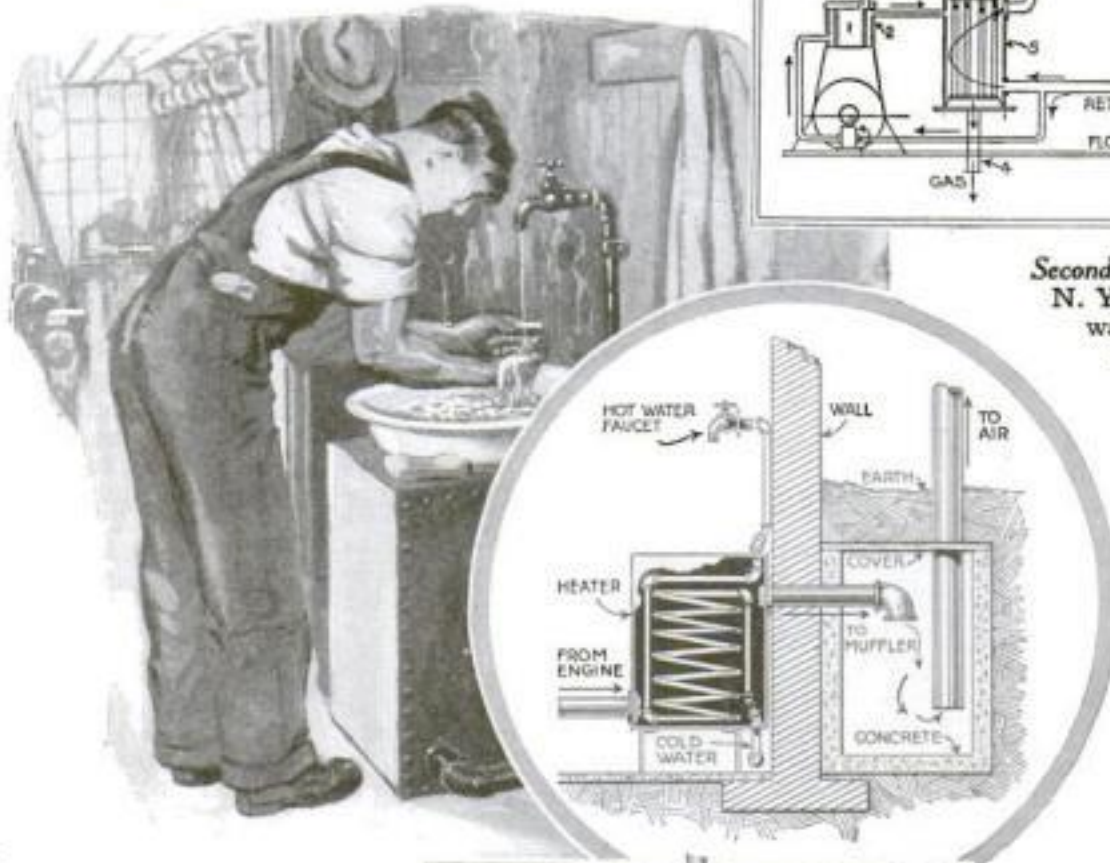
IN its September number the POPULAR for the best answers to the following question: a Gasoline Engine?"—a first prize of \$50, a the thousands of responses that came to the maga-Frank E. Covey for the first prize, the one by that by Clifford A. Butterworth for the third. number of illustrations, in the April POPULAR third prize letters are presented below, and in judges, are the next best. The contestants. A new contest

The Winner

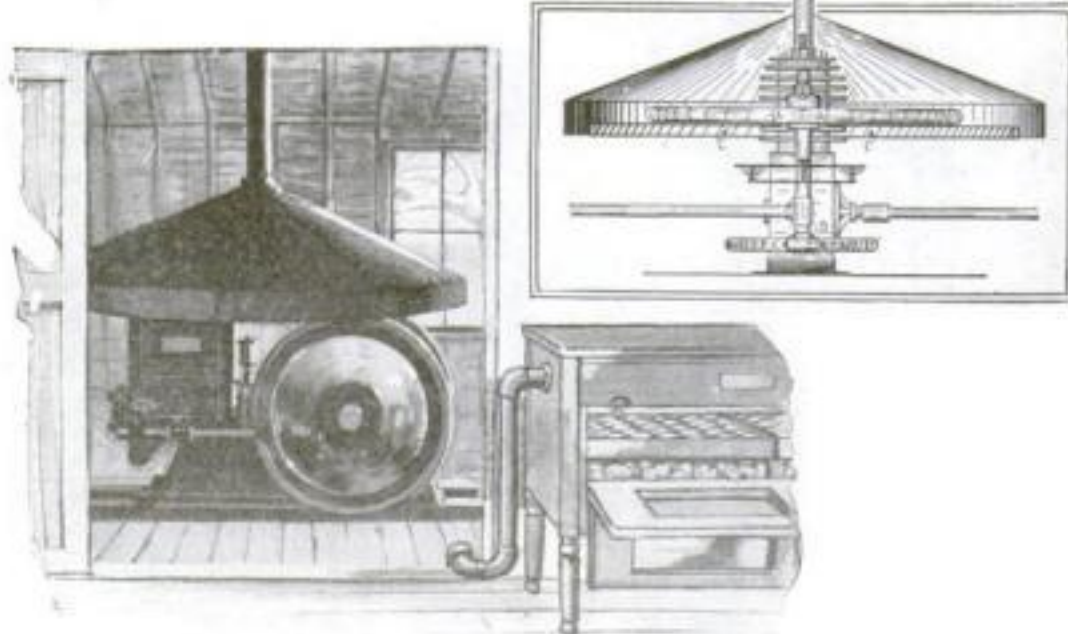
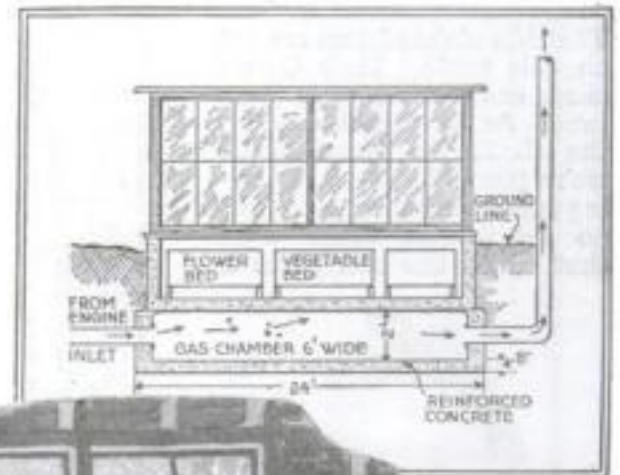
Frank E. Covey, San Francisco, winner of the first prize, submits plans for a complete internal-combustion engine in which the engine's exhaust is delivered to impact turbine buckets on the periphery of the flywheel. This article will be of great interest to the automotive and aeronautical industries. We have decided to give it an entire page of the April Popular Science Monthly



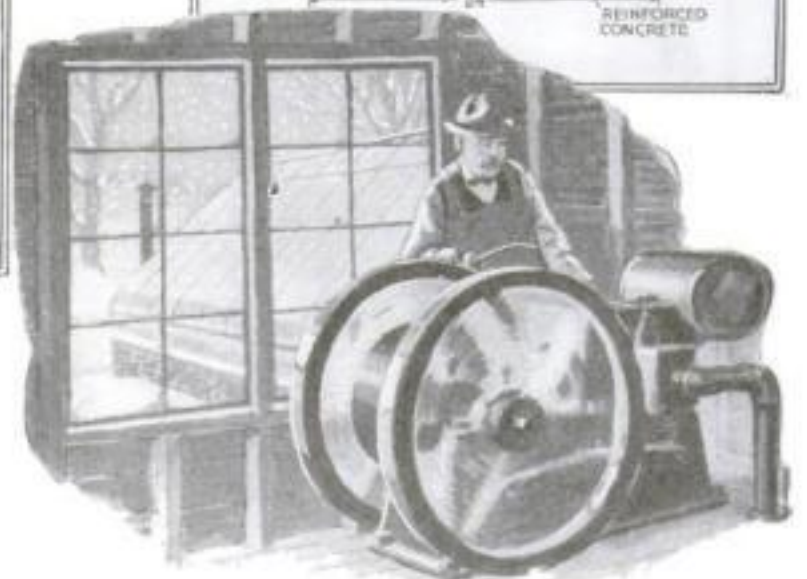
Helen E. Talbot, of Seattle, Wash., submits a heating system that gives a forced circulation of water in the system: 1 is the engine cylinder; 2 the water-jacket; 3 the circulating pump; 4 the exhaust pipe; 5 the exhaust water-heater; 6 the hot water heating system



Second Prize. George M. Petersen, of Niagara Falls, N. Y., tells how to provide a machine-shop with hot water. The heater was made of sheet metal, with a copper coil of the instantaneous type. The cold-water pipe enters the heater at its bottom and runs up to the top, feeding down through the coil so that the direct blast of the exhaust will send it forth hot



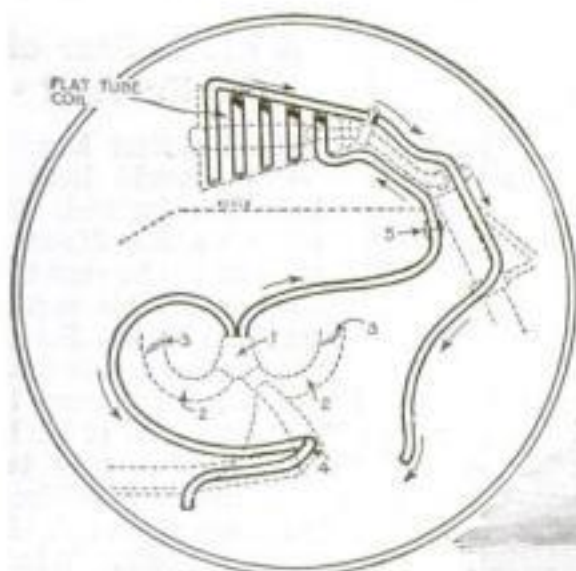
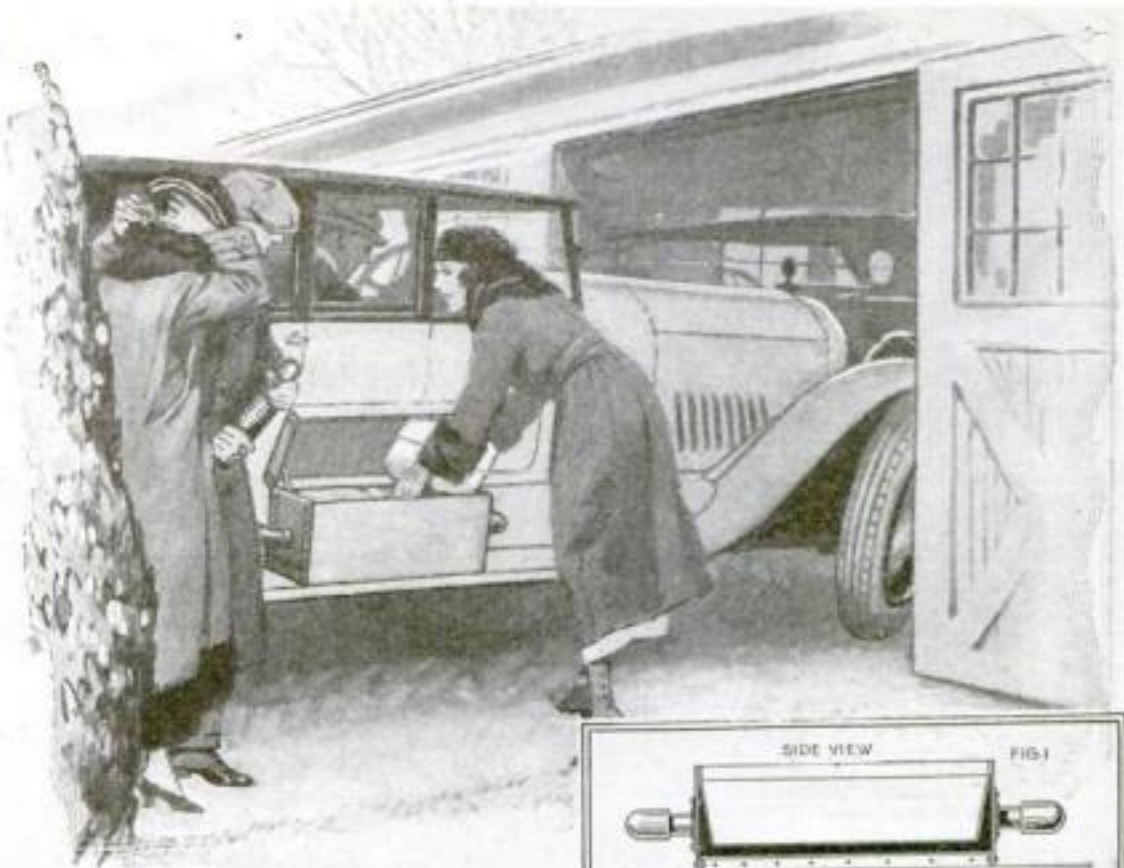
R. U. Clark, 3d, of Barnes Road, Newton, Mass., submits an apparatus for chick-brooding in connection with an air-cooled stationary engine. A small motor, covered with a conical reflecting dome and surrounded by coils of the exhaust, is its main feature



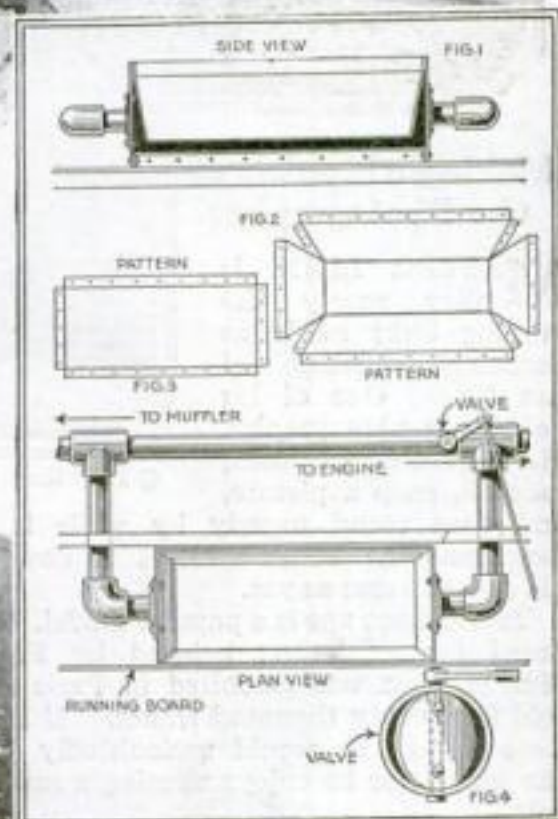
Paul L. Fetherston, of Milton, Wis., suggests plans for a greenhouse to be heated by the exhaust of a forty-horsepower kerosene engine, operated on an average of five hours a day. The heat thus stored is slowly radiated through the floor of the greenhouse

Things that Can Be of a Gasoline Engine

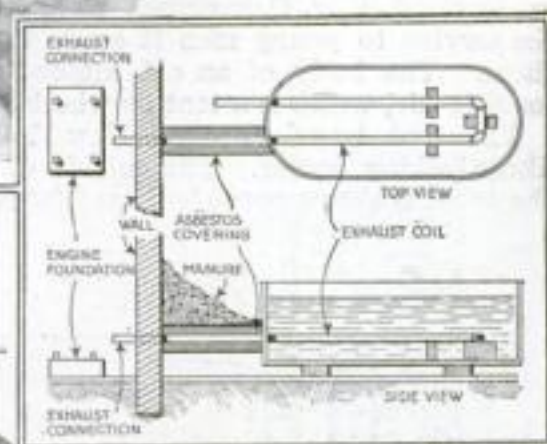
SCIENCE MONTHLY offered three prizes "What Can You Do with the Exhaust of second of \$25, and a third of \$15. Out of zine the judges selected the one written by George M. Petersen for the second, and The first prize story will be printed, with a SCIENCE MONTHLY. The second and addition the five that, in the opinion of the editors thank both the winning and losing is announced on page 114 of this issue.



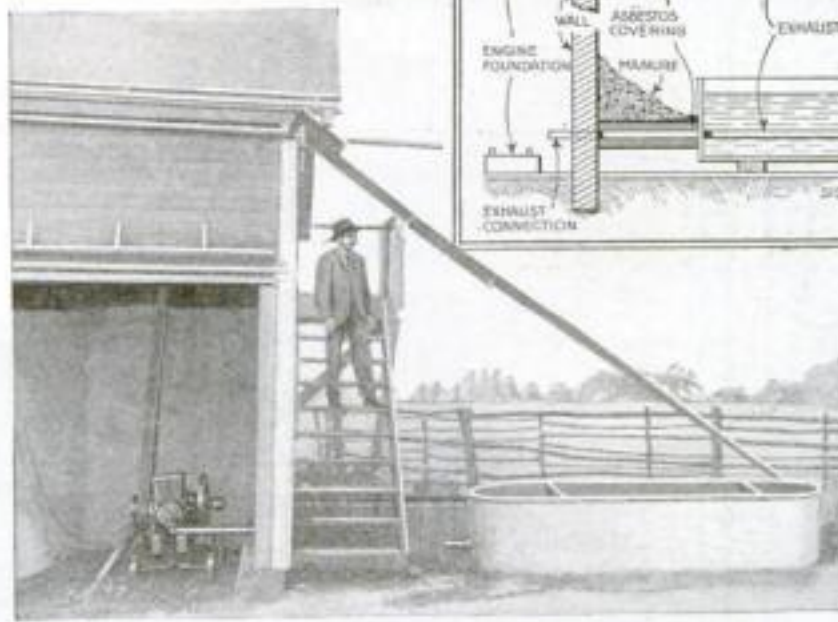
Third Prize. Clifford A. Butterworth, of Newton Center, Mass., made a cooker for touring. The construction is clearly shown in sectional view Fig. 1. Fig. 2 is the food-container, and Fig. 3 is the pattern for the bottom of the case. Fig. 4 shows the heat-regulating valve. The illustration shows how the cooker looks when mounted on the car



"In the cool days of spring and fall," says P. J. O'Neill, of Detroit, "the motorcycle is a very uncomfortable means of transportation, so I decided to utilize the heat from the exhaust of my engine to warm my hands and feet. No. 1 is a 1-inch pipe Y which was reamed to fit two pieces of 1 1/4-inch steel tubing; 2 and 3 are butterfly valves; 4 the shield; and 5 a flexible joint



Harry H. Phillips, of Waukesha, Wis., used the exhaust of a stationary engine to keep the water in a cattle-tank from freezing. He ran a single-loop coil of 3-inch



galvanized iron pipe to 3 inches of the bottom of the tank, and connected it to the exhaust pipe of the engine. Needless to mention, it worked perfectly



Making a Monkey of the Photographer

MASTER LINK is very nearly the missing link; he is as human as a dumb animal can be. One of his hobbies is photography. He will set up a camera, focus it, snap a picture, and then stand eagerly by while it is developed—he hasn't learned to develop his own pictures as yet.

This famous ape is a popular model. He posed for a picture, painted by Franz Simons, that was exhibited in Paris and sold for twenty thousand francs. If Link were a man he would undoubtedly join the navy; for he enjoys wearing a sailor's suit.



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Tearing Down the Victory Arch

WHEN the war ended, New York built a great Victory Arch across Fifth Avenue; it cost forty thousand dollars. Under it passed New York's returning heroes and distinguished visitors.

But, now that New York has done all the victory parading it intends to, the arch is being torn down.



A Movie Star of the Future?

THE fattest boy in the world lives at Leicester, England. His name is Lenny Mason—yet you can be sure that no one but his mother calls him Lenny. Fatty's waistline measures sixty-

nine inches; his chest, sixty-four; his thigh twenty-eight; and the calf of his leg twenty-four. So far, he has only two chins, but of course he may cultivate more, for he is only sixteen years old. He weighs thirty stones, we are told. What's a stone? The dictionary tells us that it is about fourteen pounds. Thus Fatty's weight, translated into United States English, is four hundred and twenty pounds!

Where the Office Seeks the Man

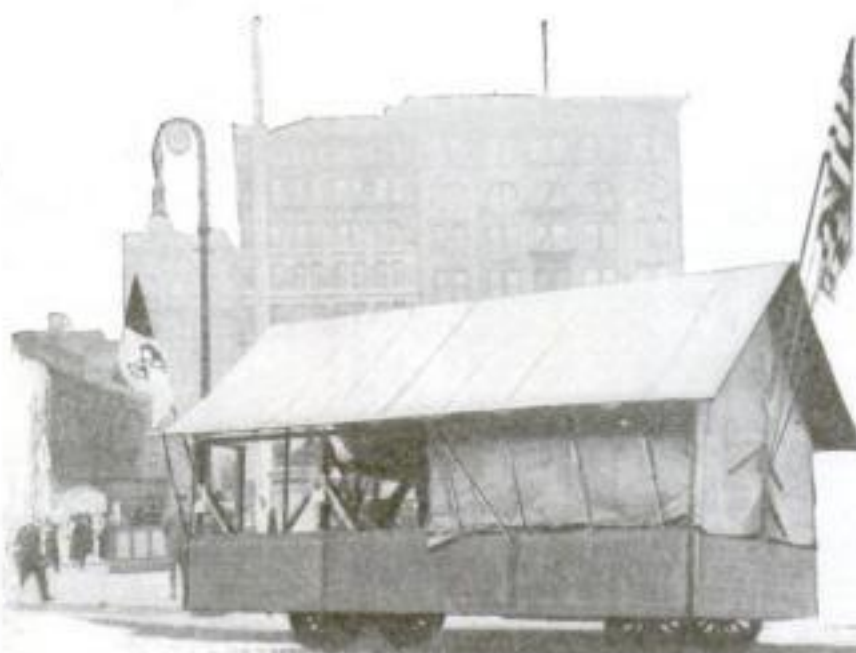
"GO two flights up and see the sergeant," used to be the direction given the would-be soldier or sailor; but a modernized War Department is more businesslike. To "sell" the service to young men it sends the recruiting office out after them. The body of an old motor-truck forms the foundation for this one, which is a tent on wheels.

The tent travels around New York city, stopping at any likely-looking corner. The outside of the platform built around the truck makes a good signboard for recruiting slogans.

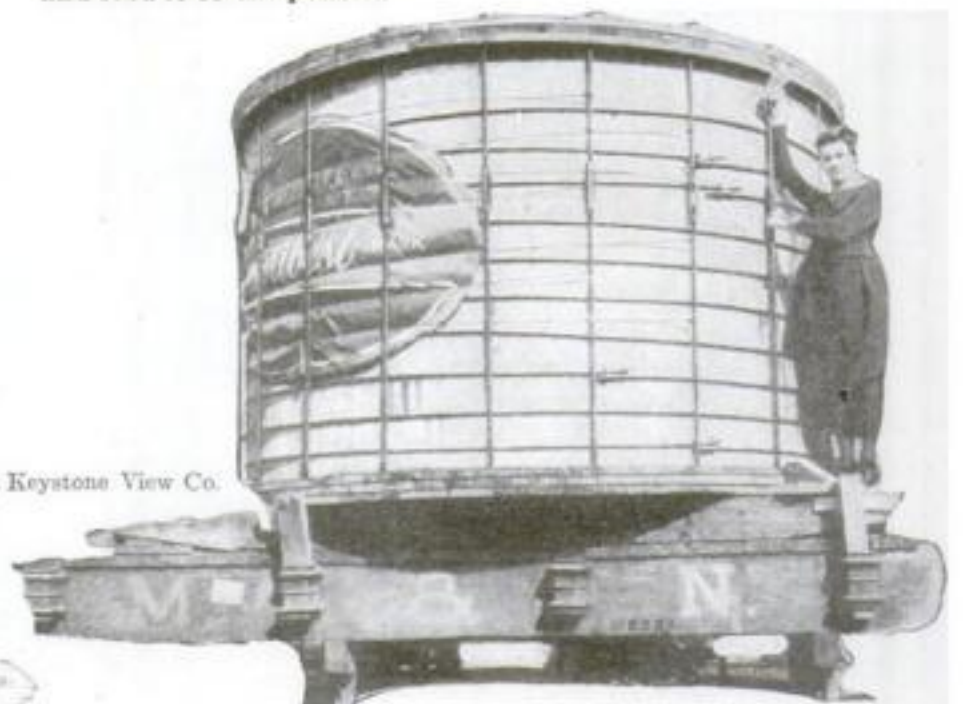
Enough Cheese for a Lifetime

A BIG cheese! Most of us have called our enemies that at some time. But did we realize what we were talking about? A big cheese—in fact, the biggest cheese—is shown in the picture below. It weighs more than forty thousand pounds, and is ten feet in diameter.

We are told that it was "built" by Mr. N. Simon for the National Dairy Show in Chicago. It was held together by metal rods and bands. It was planned to open it at the show and feed it to the public.



© Keystone View Co.



He Put a Rudder on His Sled

SLEDS that are steered by the rider pushing a bar at the front came in just in time to save fathers from bankruptcy as shoe prices soared. But one youngster at least wasn't satisfied with this improvement on the old-fashioned heel-and-toe method of steering.

"My sled just flies down the hill," he was boasting, when his ear was caught by the word "fly." That naturally suggested airplanes, and airplanes as naturally suggested—well, look at the picture. Thus are inventions born. The result was an aerial rudder, which the inventor says is not only good fun, but a real advance in steering apparatus for sleds.

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Gid-dap There, Llama

LAMAS are used in South America as beasts of burden. But when a few choice ones are picked out for foreign Zoos, they quit work entirely and lead a life of luxury—except in some of England's Zoos.

There they are harnessed to a wagon for amusing children. The head keeper of their new home trained them to draw a wagon, and now every day they travel the paths of the Zoo, carrying a load behind them. The llamas may not like it, but after all it is for their own good; we have long been told that "idleness is the devil's workshop."



© International Film Service



No Females Allowed on This Holy Mountain

CLINGING to the cliffs at the top of Mount Athos, in Greece, the wooden rookeries shown in the picture above may be considered the most modern thing in cliff dwellings or the most ancient in skyscrapers, depending on the point of view. The clustered buildings house the Rossikon monastery. The population of Mount Athos is about six thousand, of whom perhaps half are monks. Not only women but all female animals are excluded from the holy mountain.

I'll Shoot You a Game of Pool

THEY are making the game live up to the phrase in some New York pool-rooms, where "machine-gun" pool has been introduced.

Inside the barrel of the pool gun is a miniature cue driven by a strong spring. The player places his cue ball in the gun, aims at the ball he hopes to drive into a pocket, and fires. The pool gun has sights to help direct the aim.

© Keystone View Co.



A Trap-Door for Cards

BRIDGE fiends inspired Frederic J. Muspratt, of St. Helier, Channel Islands, to invent a card-table with a trap-door in the center through which the cards may be dropped when each hand is over. Instead of simply picking up the cards and shuffling them, you fish around under the table's edge for a lever, pull it, and wait till all the cards have disappeared before you let go. Then you gather the cards from the tray. The object of the device is speed.

We doubt the efficiency of this trap-door method of gathering cards; but by accidentally moving the lever you might rid yourself of a bad hand.



Josephine the Joy-Rider

BELOW you see Josephine riding in an automobile. Josephine is a cow of the Jersey persuasion, and her chauffeur is a Baptist minister of Bolivar, Mo. A member of his church gave Josephine to the minister on condition that he would carry her home in his car.

Both rear doors of the car were dropped open and the floor between the seats was filled with straw. A temporary chute was constructed, and the cow was led into the car and securely lashed fore and aft. She stood up most of the way home, her feet resting on the running-boards on each side of the car.



Flying Straight Up with Whirling Wings

The helicopter's most recent advocate is the scientist and inventor, Peter Cooper Hewitt

By Marius C. Krarup

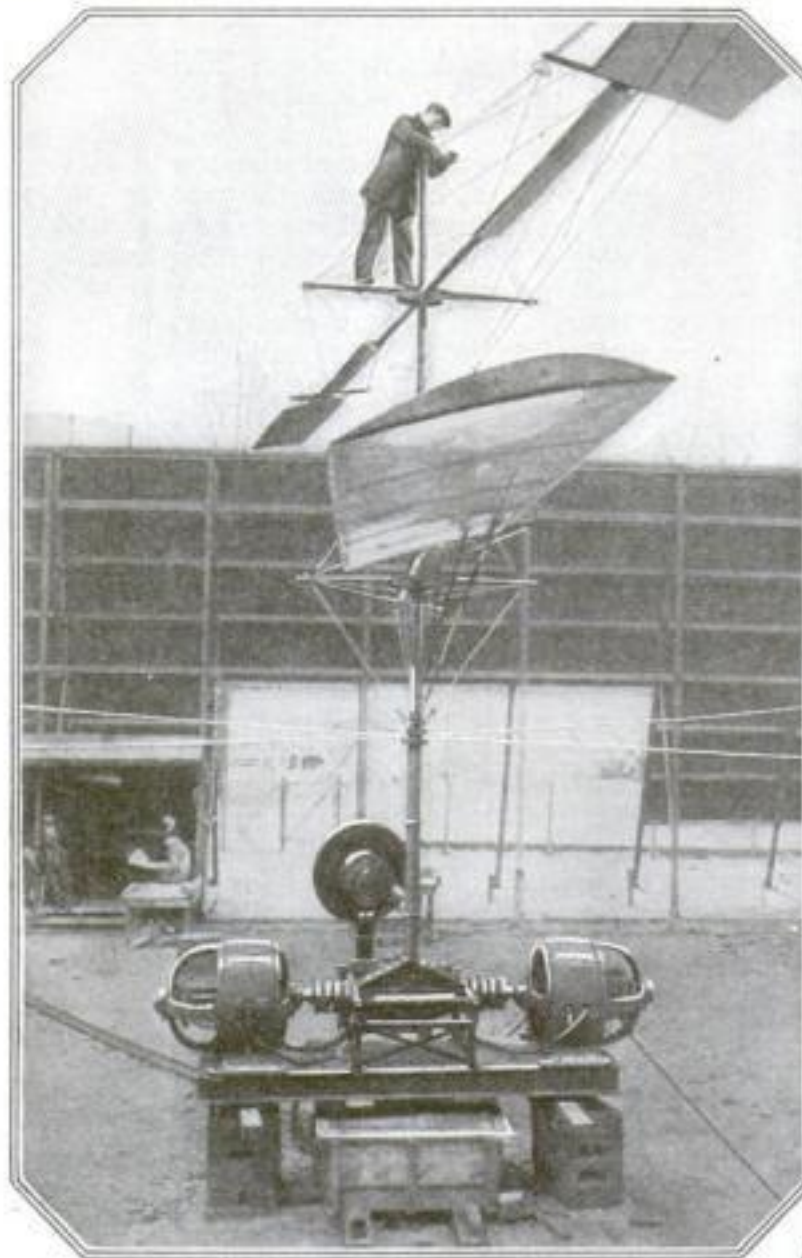
A NOTED scientist, Peter Cooper Hewitt, inventor of the mercury-vapor electric lamp, recommends flying on the plan that Leonardo da Vinci said he would adopt if he had the power. In other words, Cooper Hewitt advocates a helicopter, which means that his machine is to be lifted by a screw propeller which rotates horizontally to obtain lift and obliquely to obtain both lift and propulsion. By twirling a toy propeller in the fingers with its shaft at forty-five degrees, one observes that when the blade on one side is in a position that gives lift, the other blade is in a position to give propulsion. By varying the angle of the shaft, lift and propulsion can be obtained in different proportions. The machine goes straight up when the shaft is vertical, and it flies horizontally when the shaft is inclined so that the lift produced is just sufficient to keep the machine suspended.

If only one helicopter screw were used, the engine driving it would spin itself around in the opposite direction. Half the power would be wasted and the pilot much discomfited. The plan therefore calls for two screws mounted on telescoping shafts and driven in opposite directions. For inclining the double shaft at the will of the pilot, one or more auxiliary small screw propellers may be used. When the engine and body of the machine are hung considerably below the helicopters, as in the testing apparatus shown herewith, the push required at the level of the engine for slanting the main shaft can be very moderate. Once the machine flies horizontally by this means, the wind resistance against the body helps to maintain the slant. If it is reversed by the auxiliary propellers, the machine flies in the opposite direction. All steering, up and down and sideways, can thus be accomplished by managing the slant, but Mr. Hewitt does not as yet disclose the mechanism that he proposes to employ for this purpose.

When a surplus of power is suddenly applied, the machine jumps in the direction in which it is aimed, as it has only its weight but no great areas of body and wings to retard it. If the power gives out, the machine falls; but the helicopters prevent spinning, having opposite pitch, and break the velocity of the descent somewhat.

So far, the helicopter plan has had

no followers except in theory, mostly because the lift thrust obtainable from an ordinary propeller screw is very small. It is difficult to get more than a 200-pound thrust from an eight-foot propeller at one thousand revolutions a minute. This small thrust will operate at great forward speed when given the chance, as is done in the propulsion of an airplane, but that does not help to lift the much greater weight of a machine straight up, ever



© International Film Service Co.

P. C. Hewitt's helicopter test machine. When the electric motors are replaced by engine and auxiliary propellers for starting the helicopter mast, and when room is made for a pilot, this apparatus becomes a flying-machine

so slowly. For that purpose the thrust must exceed the weight. And to use many small helicopters in one machine is practically impossible. It is particularly difficult to slant them all, for propulsion. Besides, small helicopters revolving at high rotary speed are at best very inefficient. The centrifugal forces are troublesome and wasteful.

The extensive experiments made by Mr. Hewitt show the only way in

which helicopters can be used. They must be very large. Those shown in the illustration are fifty-one feet in diameter. The four blades are twelve feet long and two feet six inches wide. They are really airplane wings mounted to be whirled around. The maximum rotary speed used is seventy revolutions a minute, but this gives a linear speed of one hundred miles an hour at the middle of each blade.

To get a lift of 2,550 pounds with this machine it is necessary to rotate the helicopter at 70 revolutions a minute and this requires 126.5 horsepower. At 46.5 revolutions a minute the power is more efficient, since at this speed 44.4 horsepower lifts 1,300 pounds, but this lift is not of any use if the machine weighs more. What the lift must be when part of the power is used for propulsion does not seem to be determined as yet. If 126 horsepower is required for supporting a machine weighing 2,550 pounds and more for flying it, the helicopter plan does not yet promise an efficiency equal to that of an ordinary airplane.

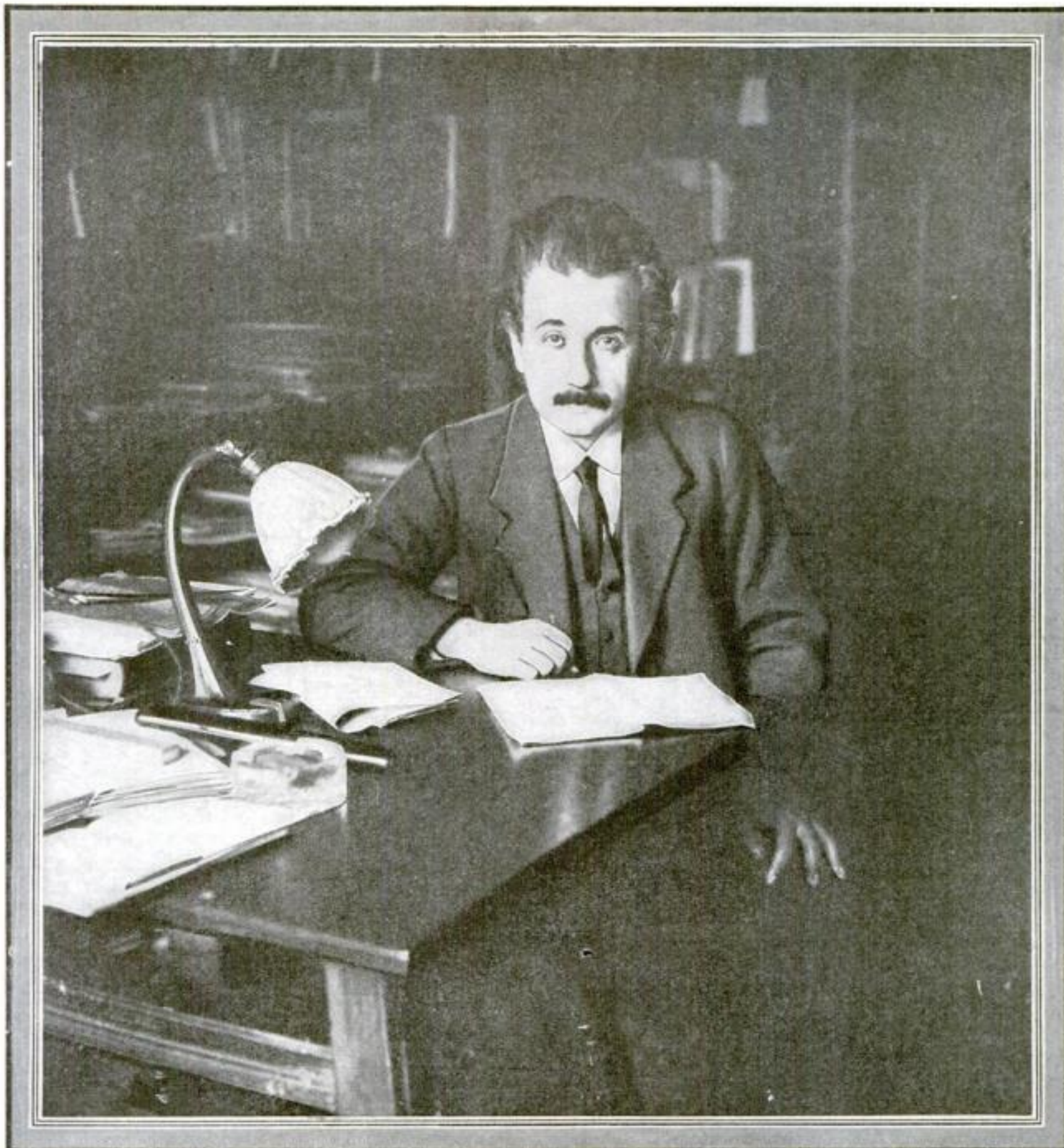
The following table gives results obtained with the Peter Cooper Hewitt helicopter testing apparatus:

Revolutions per minute	Lift in pounds	Horse-power	Pounds of lift per horse-power	Velocity in feet per second at 20-foot radius
46.5	1300	44.4	29.3	97.5
56.5	1800	75.4	23.9	118.3
63	2150	98.4	21.8	132
70	2550	126.5	20.2	146.5



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During a recent test of his helicopter flying-machine, Mr. Hewitt was accompanied by Thomas Edison, who displayed a keen interest in the invention



Once They Would Have Burned Him at the Stake

MEN have been tortured and burned at the stake for upsetting ideas. Galileo and Copernicus had a hard time of it in their day. Now comes a revolutionist, an idea-upsetter as great as any. He is Professor Albert Einstein, and his idea-upsetting "theory of relativity" will make it necessary to rewrite Newton's laws of gravitation and every text-book on physics.

Einstein starts with two suppositions. One is that all motion is relative. In the cabin of a ship you cannot tell whether you are moving or not without looking out of the window. Is a man who is walking from stern to stern of a ship at the same rate that the ship is moving in the opposite direction standing still or not? If astronomers could not see the stars, they would not know that the earth is moving.

Einstein's second supposition is this: The speed of light (186,000 miles a second) cannot be increased or diminished. This is like saying that the speed of a rifle bullet is always the same when it is fired forward or backward from an airplane going at one hundred and

twenty miles an hour. Nothing can be faster than light. Newton says that gravitation acts instantaneously throughout space. "No," says Einstein, "the action of gravitation is not instantaneous; it cannot exceed the velocity of light."

What is your size? What is your shape? "Tell me how fast you are moving and in what direction," says Einstein, "and I will answer. If you are traveling vertically upward at the rate of 136,000 miles a second, you are not six feet tall, as you supposed, but just three. But horizontally you will measure six feet. It is no use to bring in a standard yard-stick and start to measure, for that too contracts and measures only a half a yard vertically held."

Light is a form of energy. Therefore, says Einstein, it must have mass and must be affected by gravitation. In other words, you ought to be able to weigh light. But how? It moves so fast that it cannot be weighed on the earth. If we could see a star close up to the edge of the sun, a ray of light coming from the star would bend under its

own weight, and the star would be seen, not where it actually is, but a little bit to one side. During the last solar eclipse exactly what Einstein predicted happened. A light from a star was deflected, just as a bullet fired from a gun gradually curves toward the earth. We can safely speak of a pound of light now. As a matter of fact, the sun showers on the earth 160 tons of light daily.

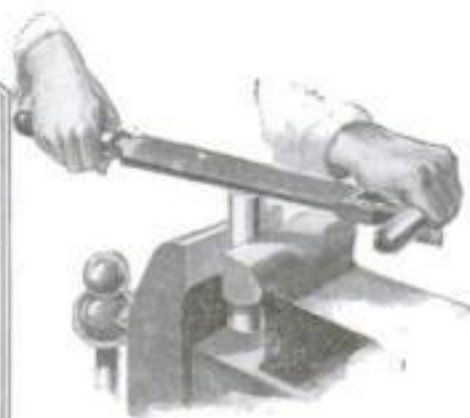
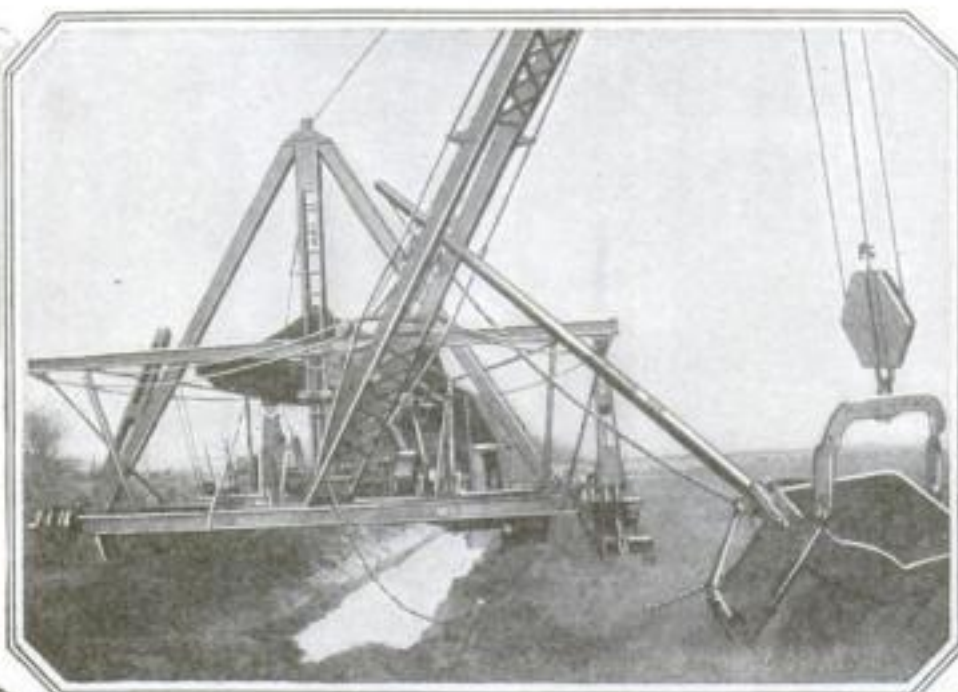
Other astonishing consequences follow as soon as Einstein's theory of relativity is accepted. Straight lines do not exist. They are parts of gigantic curves. Travel fast enough on a straight line, and you will come back to your starting-point. It would take a beam of light 30,000,000 years to describe a complete circle.

All this seems like sheer nonsense. And yet, Einstein's statements have been proved to be true by experiments! You have been living in a dream world. Your conception of time and space are true only within limits. "Wake up," says Einstein, "and acquaint yourself with the real world."

Do It with Tools and Machinery



John Weaver, of Baltimore, has invented a completely insulated screwdriver, something that has long been in demand by the electrical trade. Should the device slip on live circuits, it is rendered harmless by its insulated shield



A recent improvement is this extra handle to be attached to a file and permitting it to move backward as easily as it does forward

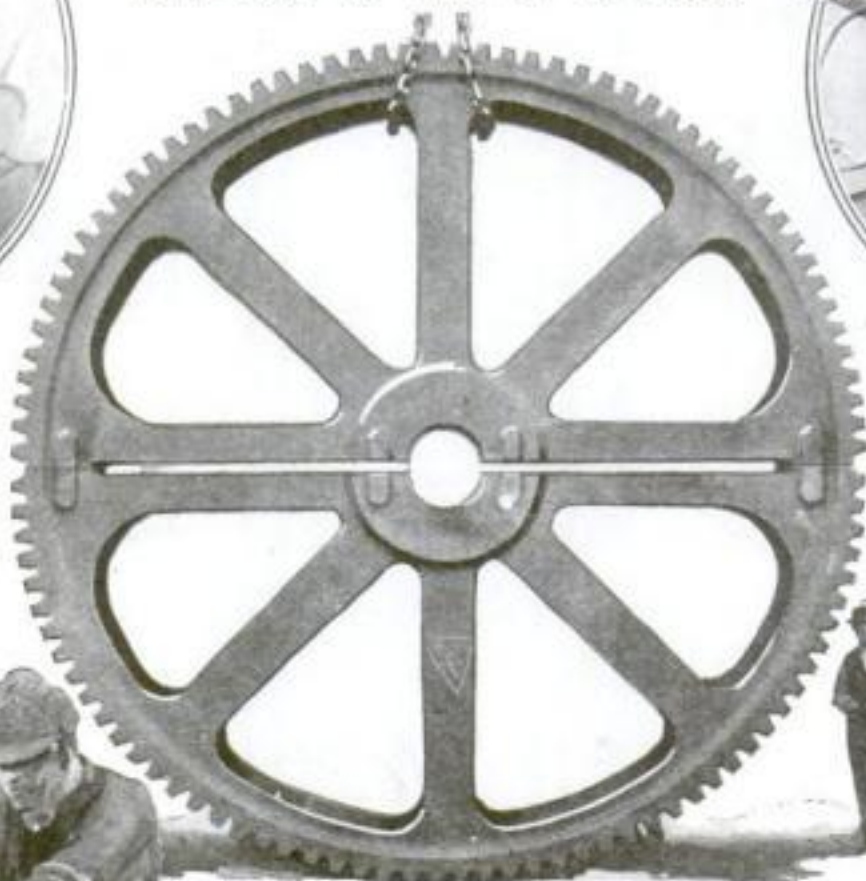


A grinding-wheel dresser, so made as to produce the proper form of wheel for grinding various radii, has recently been placed upon the market. The illustration above shows the dresser in operation

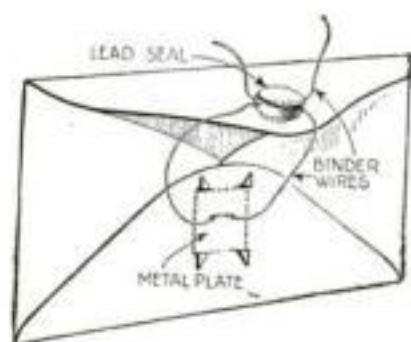
A transporting attachment permits the dredge to be propelled backward with the same facility as forward. The dredge rests upon skids on top of which are steel rails, the skids sliding forward by belt and pulley power from the engine of the dredge



The operator plugs the connecting cord into the light socket, lays the metal to be marked upon the electrical engraver's contact plate, and the engraving is made without wax, stamps, or acid



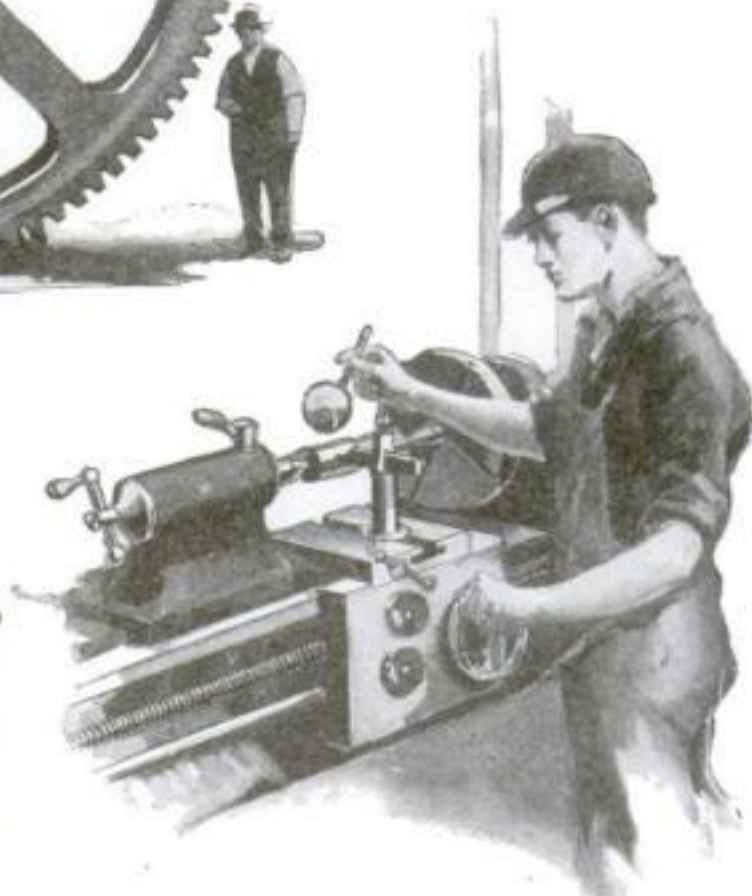
This gear was cast in one piece and then cut in two. Its diameter is 16 feet 8 inches, and its weight 70,000 pounds. The teeth are 28 inches across and there is room for a man's arm between two of them



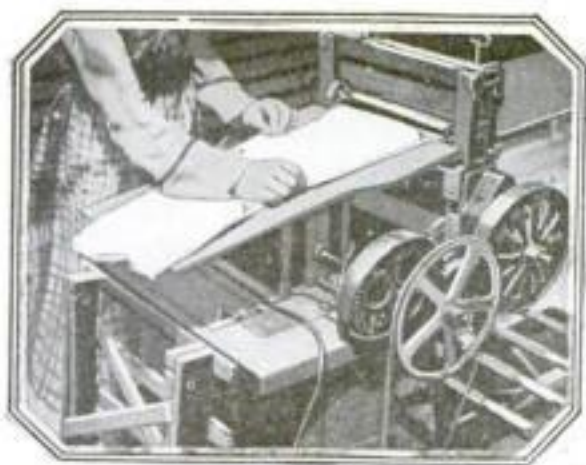
A clip that is shaped from thin metal and provided with prongs for securing the back part of an envelope or binder



Driven into the tree to be cut down, this saw oiler lubricates the saw automatically as it passes back and forth beneath it



A magnifying mirror for shop use: it is adjustable to any angle, and can be inserted in a surface gage or other instrument

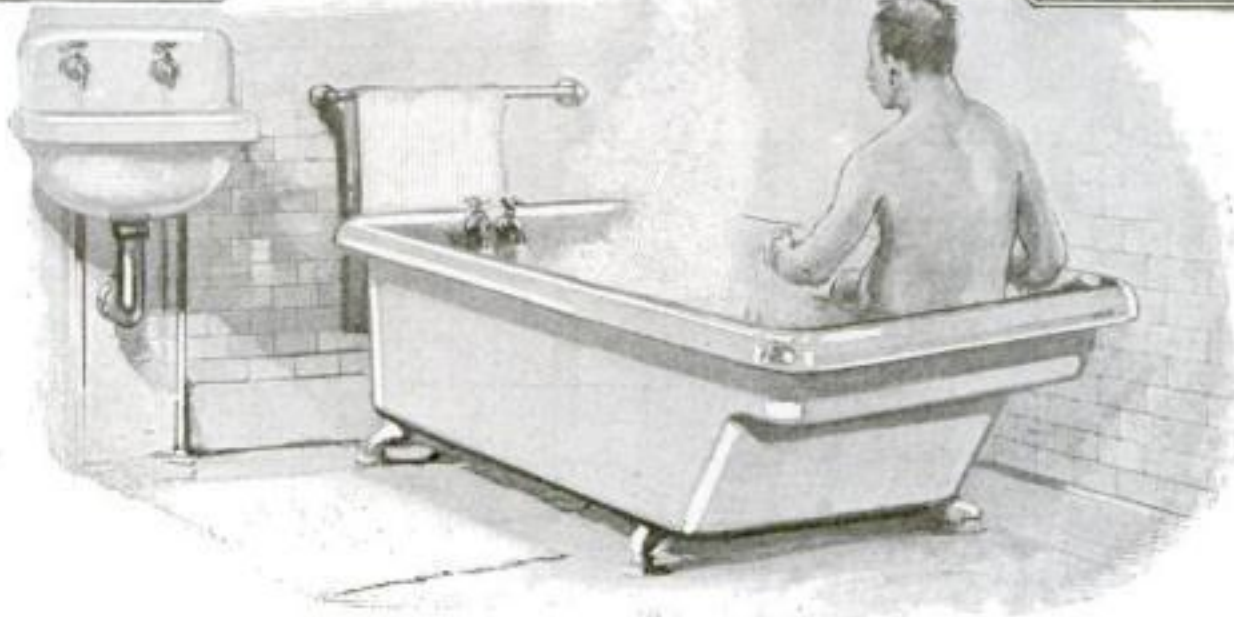


Here is an electrically heated clothes-mangle: attached to the washing-machine wringer; it is said to do the family ironing in one third the time formerly taken

Inventions that Will Help Make the Housewife's Job Less Hard



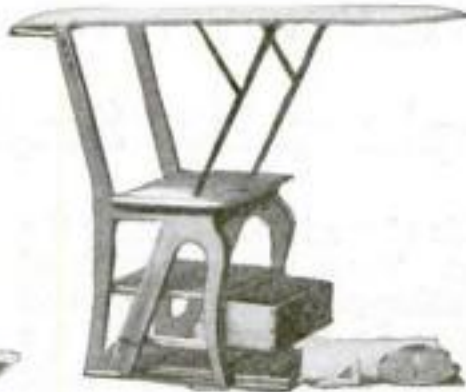
This little sewing-stand, with its hanger places for spools, scissors, and sewing material, folds up exactly as would a book, and hides behind the door when not needed



A new bath-tub is so designed that it offers the occupant either a head-rest or a seat at one end of the tub



An unusual but very practical soap-holder is shown here. The cake of soap is simply set upon the prongs, which prevent it from slipping



The combination chair, step-ladder, and ironing-board is for the two-by-four apartment. It is entirely practical and saves buying three separate kitchen articles



For the theater and the home is this automatically closing bag, hat, or program holder. When not in use the spring lug snaps back into the pear-shaped holder



The fumes of burning benzine cause the metal in the perforated box to glow for eight hours at a time, making this little hand-warmer a useful thing in the cold weather



© International Film Service

The ashes from the kitchen range are placed in a sifter built almost like an ice-cream freezer: The sifter is made air-tight



This folding stool for the bathroom is set compactly against the wall, out of the way, when not in use: Very useful in small bath-rooms



Push down the pin, insert the rubber cork into the neck of the bottle, release the pin, and the cork will expand sufficiently to cork it: It will fit any bottle of reasonable size

A Fight between a Steam and an Electric Engine



THE fight for the heavy-weight championship was about to start. Down the tracks from opposite directions came the fighters—a great two hundred and sixty-five ton electric locomotive versus two monster steam locomotives. When the gong sounded, the steam locomotives started up and shoved the electric one down the track. Then the power was turned on in the electric, and it began to push in the other direction. The steam engines slowed down, stopped dead, and then retreated, though their throttles were opened to the last notch! One, two, three, four—the steam engines

were counted out, and the electric won the championship. This powerful engine is one of the new gearless electric passenger locomotives that are being built by a large electric company at Erie, Pa. It is seventy-eight feet long, eighteen feet high, and has a horsepower of more than three thousand. There are fourteen motors that turn fourteen sets of driving wheels. And these motors may be used as electric generators and send back quantities of "juice" to the power station. This process of regeneration acts as a brake at those times when the engine is traveling downhill

IMAGINE yourself aboard an airplane, crossing a wide stretch of water. You are enjoying the scenery, when suddenly the motor begins to stutter. A few half-hearted explosions, a grating sound, and—the engine stops. If you are flying low and far from the shore, you must face a landing on the water.

Lower and lower soars the airplane; the wind whistles past the bracing-wires—suddenly the machine hits the water with a tremendous crash. Half a wing is carried away by the waves. But you are safe—for the time being. In a few minutes the machine settles lower and lower in the water. Then, when you have given up hope, a hum is heard in the sky, and a giant flying-boat lands close to you and takes you off the wrecked airplane.

Buoyancy bags, a new invention, will soon be found on every machine that has to traverse wide stretches of water. Colonel Busted, of the British Air Service, and Lieutenant Labranche, of the French Aviation Corps, are the inventors. Two air-bags are fitted

Turning Airplanes into Seaplanes

on each side of the fuselage, under the lower wing. These bags are made of flexible rubber-proofed fabric, and when empty lie quite close to the fuselage, offering scarcely any resistance in flight.

The bags are inflated by means of an air-bottle containing compressed air under a pressure of 2,000 pounds

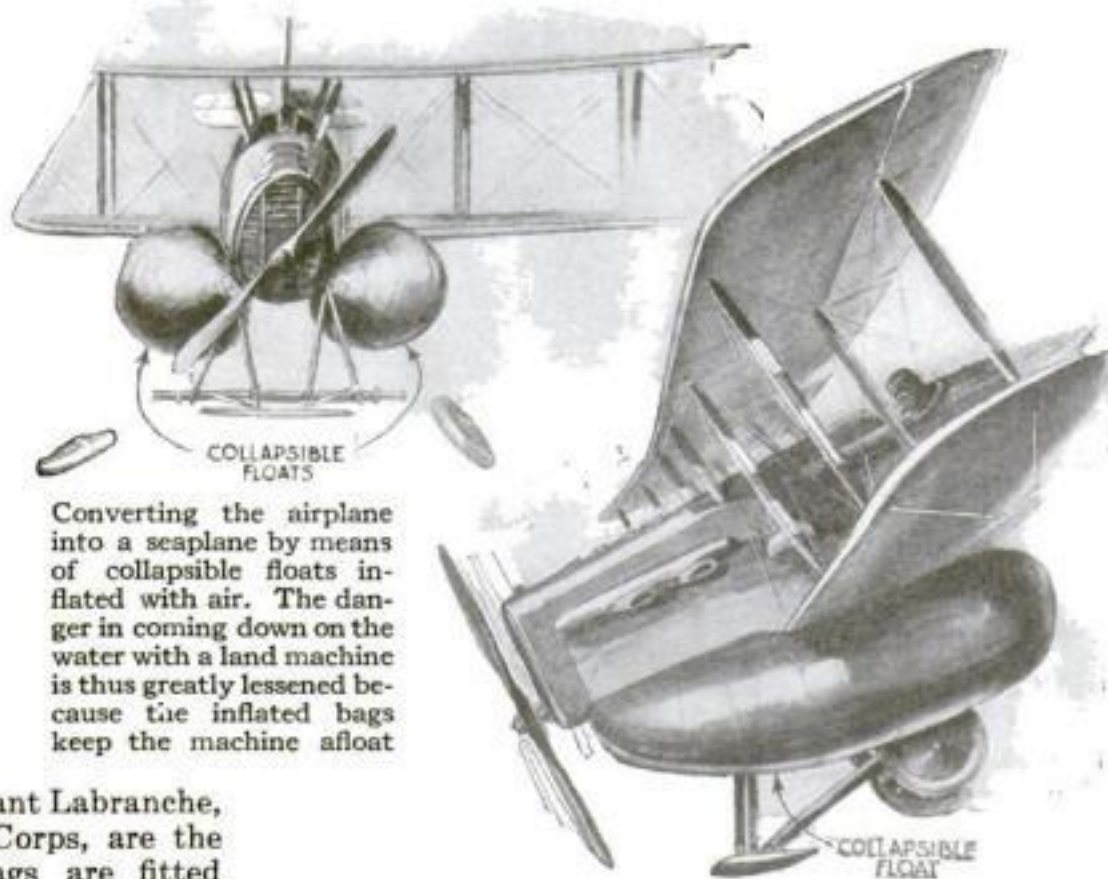
per square inch. Since the bottle is very small, to save weight, it does not contain sufficient air to fill the bag completely.

In order to increase the volume of air, a very ingenious device, known as an injector, is used. This injector has several nozzles which communicate with the outside air; when the valve on top of the steel bottle is opened, air rushes at tremendous speed

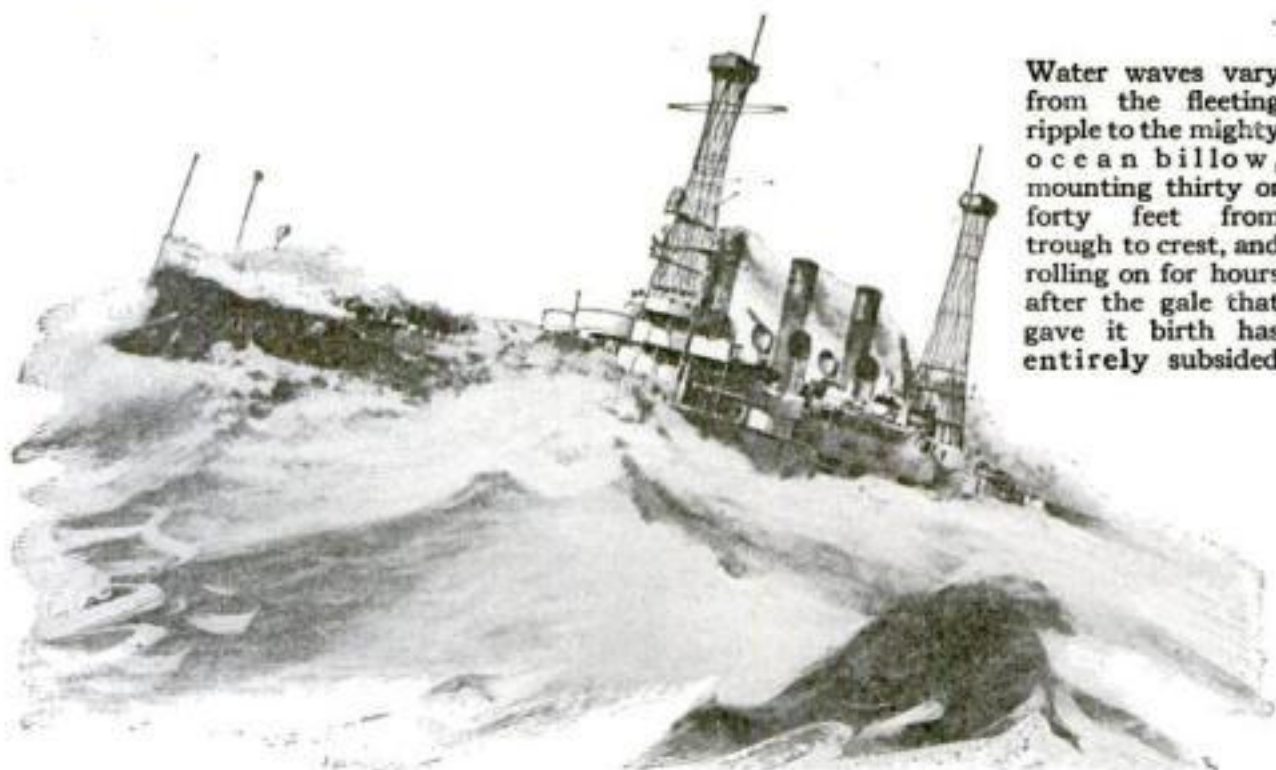
into the injector and then into the bag, which becomes rigid.

A landing vane, about one foot wide and five feet long, is fitted in front of and below the air-bags. This glides over the water, just as the bottom surface of a seaplane floats, and absorbs also the most severe shocks, which otherwise might burst the air-bags.

In some machines, the inflated bags might foul the landing wheels of the airplane; a special device is used in such cases, which enables the pilot to throw the wheels off just before inflating the air-bags.



Converting the airplane into a seaplane by means of collapsible floats inflated with air. The danger in coming down on the water with a land machine is thus greatly lessened because the inflated bags keep the machine afloat



Water waves vary from the fleeting ripple to the mighty ocean billow, mounting thirty or forty feet from trough to crest, and rolling on for hours after the gale that gave it birth has entirely subsided

motion a swing with an adult sitting in it. This is a typical example of what is called resonance. The swing has a certain natural period of vibration, just like the pendulum of a clock, which makes one, two, or more beats every second, according to its length and the construction of the clock.

Now, this is a perfectly general property of bodies or systems capable of vibration—that they have a definite period of oscillation, depending on their dimensions, and that, if the proper kind of force is applied at regular intervals corresponding with their natural period of vibration, even a small force is capable of producing very powerful effects. This is the reason why troops marching over a bridge are always ordered to break step. Were they to march in unison it might happen that their footsteps kept time with one of the natural periods of vibration of the bridge or some of its members. Serious results might then follow. A suspension bridge at Manchester, England, many years ago actually collapsed under the hoofs of a troop of cavalry.

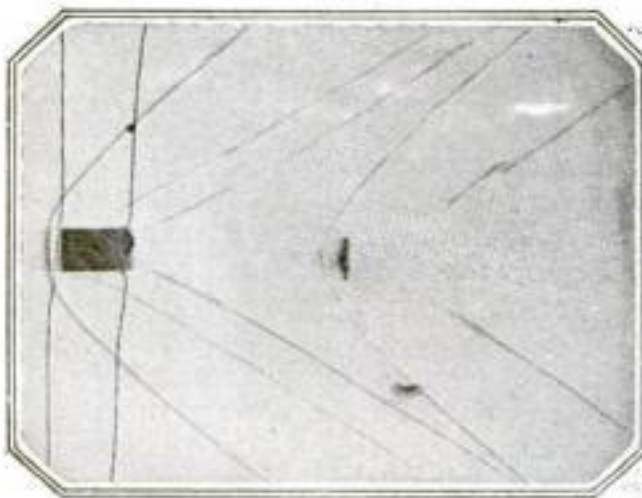
Danger of Oscillation

Similarly, a building may be perfectly safe for ordinary use, and its floors able to support the weight of heavy machinery; yet this same building might be thrown into violent vibrations if its natural period of oscillation should happen to coincide with the rate of revolution of a motor installed within it. The same kind of effect is liable to occur and has to be guarded against in the design of electric installations. If the dimensions of the electric circuit happen to stand in a certain numerical relation, powerful surges are liable to arise, which would either burn out the conducting lines or else break through the insulation; the period of revolution of the dynamo, and hence the fre-

quency of the alternating current, coincides with the natural period of oscillation of the circuit.

Perhaps the most familiar example of resonance, the one after which the phenomenon has been named, is that of a body set into vibration by sound waves striking upon it. If you lift all the dampers off the strings of a piano by pressing down the "loud pedal," and sing any note of the musical scale into the body of the instrument, after the sound of your voice has died out you will hear certain of the strings vibrating and giving out their note, namely those strings one of whose natural periods of vibrations coincides with the note you sang into the piano.

Waves in the water, waves in the air, waves in the earth—there we have at least something tangible. But waves in the empty space between the stars—how can that be? The question is hard to answer. Modern developments seem to indicate that our diffi-



A brass bullet with a hole through the center was shot from a rifle and photographed in the act. The high velocity of the bullet did not permit much air to pass through the hole, and thus the front air wave does not differ from that of a flat-headed bullet. But the air that did pass through hit the vacuum at the base of the bullet and started a sound wave. The friction of the air along the sides of the bullet is seen

culties in answering it are psychological at least in part. Just as the ear is deaf to sounds outside a certain compass of frequency, so the human mind may be incompetent fully to grasp certain facts and relations of nature. Perhaps the human race will have to recast its conceptions of time and space before it is able to gather into the realm of understanding certain aspects of such phenomena as the journey of light from sun to earth. But this we know: that light does travel through what is for all ordinary purposes empty (airless) space, and, in fact, travels through such empty space with greater ease and at a higher speed than even through the most transparent glass. And we know, further, that in its travel light displays all the characteristics of a wave disturbance; that

it travels through space with the perfectly definite velocity of 186,000 miles a second, identically the same as that of the electric waves employed in wireless telegraphy. It is one of the feats of the genius of Clerk Maxwell, that he predicted the existence of these waves on theoretical grounds alone long before they had ever been observed, and that he identified light with them.

The wave lengths of visible radiation, the "light" we see, range from about sixteen one millionths of an inch for violet rays to about thirty one millionths of an inch for red rays.

Where the Eye Fails

Just as there are sounds too "high" and too "low" for the human ear to perceive, so there is light "too violet" and "too red" for the eye to see. But the photographic plate still detects ultra-violet rays with a wave length of about four one millionths of an inch. On the other hand, though a body may not be hot enough to give out visible radiation (as at red or white heat), it may still be emitting "heat rays" perceptible to the hand or observable by means of special instruments. The wave length of these may be taken to extend to about twenty-four ten thousandths of an inch.

Above the ultra-violet waves the scale is continued in X-rays, with a wave length of about two one billionths of an inch. Below the infra-red waves comes a long series of electromagnetic waves produced experimentally and ranging from about one tenth of an inch to many thousands of feet in length.

Lastly, the earth being negatively charged, and revolving around the sun, which probably carries a positive electric charge, must send out an annual wave having the stupendous length of six million million miles!

Ready to Battle with the Deep

Clad in armor, the diver defies pressure that would crush an unprotected man to death

DOWN, down, down, the diver goes after sunken treasure. How deep? Can he reach the *Lusitania*, which lies in more than three hundred feet of water? Not with the present diving apparatus. He would be squeezed into a pulp by the relentless grip of the water.

How deep can a diver go? The record is somewhat more than three hundred feet in sheltered waters. Out in the open sea it would be difficult to descend one hundred feet. The billions of tons of shipping and cargo sunk by the Germans lie in depths of more than one hundred feet. They cannot be reached with the aid of the ordinary diver's dress.

After all, that follows from the very nature of the dress. It is but a combination rubber garment that covers the whole body from the neck down, except the hands, which protrude through elastic cuffs, water-tight at the wrists. To this flexible garment is bolted a windowed helmet to which air is pumped from above. Inflated as it is, the dress is as buoyant as a cockle-shell. To sink the diver like a stone and to keep him upright, the soles of his shoes are weighted, each with sixteen pounds of lead. In addition, eighty pounds of lead are distributed around his body. His equipment weighs about one hundred and seventy pounds. Add to that his own weight of one hundred and fifty, and the total comes to three hundred and twenty-five pounds. He is connected with the surface not only by the air-hose, but by a signal- or life-line in which telephone wires are usually embedded.

Air Within Resists Air Without

Don't suppose that air is pumped into the helmet simply for the diver to breathe. Without the air he could not descend as far as he does. It is the air pressure within the suit that resists the water pressure outside. That intense pressure must be nicely regulated, so that he will not be squeezed to death by the relentless water. The deeper he goes the greater is the pressure of the water and the greater must be the opposing pressure of the air. There is a limit to the air pressure that a man can endure. Hence there is a limit to the depth to which he can descend—about three hundred feet under the most favorable conditions.



© Underwood & Underwood

This elephantine diving armor is the invention of Charles H. Jackson. A descent of three hundred and sixty feet has been made in it. It is said to have all the faults as well as all the merits of its predecessors

But this is not the only limitation imposed by the ordinary diver's dress. A man who has gone down as far as three hundred feet may not be hauled up quickly like a fish at the end of a line. The pressure of the air has forced nitrogen into his blood; for nitrogen constitutes about 80 per cent. of the air we breathe. That nitrogen must be released very gradually. The man's blood-vessels are like a corked bottle of soda-water. You know what happens when the cork is suddenly removed; you know that bubbles shoot up.

So it is with the diver. The nitrogen in his blood would bubble off if he were quickly pulled up. The result might be instant death—certainly suffering and a case of the disease that has come to be known as the "bends." The longer he stays below, the more highly charged with nitrogen does his blood become, and the longer must be the time allowed for him to rise. If he has been working for an hour at a depth of two hundred feet it would take four hours to haul him up. Only by such tedious "decompression" is diving made a safe calling.

These being the limitations of the ordinary diver's dress, why not construct a metal suit, a rigid suit of plate mail, so strong that it would in itself resist the crushing force of water beyond three hundred feet? Let the man breathe air in ordinary atmospheric pressure,—the kind that you are breathing now,—no matter what his depth may be. Wouldn't that solve the problem? Wouldn't that enable him to come up to the surface at once

without fear of having his blood boil in the effort to rid himself of its nitrogen? Wouldn't that make it possible to go down five hundred, six hundred, even one thousand feet, and reach hulks that seem now hopelessly inaccessible?

A Negro Mechanic's Invention

Long before Germany began to sink ships by the score, inventors had tried to realize this idea. The latest of these is Charles H. Jackson, a negro mechanic. A descent of three hundred and sixty feet has actually been made with his suit. Will it mean a fortune to its inventor, and the recovery of untold wealth that now lies at the bottom of the sea?

Anyone who is familiar with the past history of diving armor will tell you that there is little originality in Jackson's suit. It has all the faults and all the merits of its predecessors. Encased in such a rigid shell, a man cannot climb down a ladder, seize a rope, and lower himself, after the traditional manner of divers. A derrick must actually pick him up and drop him overboard. Jackson's suit, for example, weighs four hundred pounds, and that is light compared with others that have been experimented with. Depths of even six hundred feet have been attained with similar armor. No difficulty in breathing is experienced. But the man within the steel shell has no freedom of movement. He looks like some elephantine creature from another world. He moves about clumsily. His arms are encased in steel, and so are his hands. They must be so protected; for the terrific pressure of the water would crush his fingers into a shapeless mass. Hence, Jackson, like other inventors, employs an artificial hand—a mechanically operated iron claw.

Salvage experts reject all these diving suits—reject them because the joints leak at moderate depths and become tight only when the great water pressure at three hundred feet or more compresses them. Indeed, some inventors actually install automatic pumps in the suit to remove the water that seeps in. The most that can be expected of a man in such a cumbrous apparatus is to locate a wreck and possibly to guide an electric lifting magnet to steel billets or a clam-shell bucket to a pile of loose cargo.



© Underwood & Underwood

As Helpless as a Fish Out of Water

Untold riches lie in the depths. Can the diver reach them? All depends on the armor. For this modern knight, if he is to secure the treasure, must meet and conquer the dragon of the great depths—crushing, deadly water pressure. That is why he is clad in steel armor so heavy that a derrick is needed to lift him from the deck of the ship and lower him over the side. If he were clad in the ordinary diving dress it would be necessary to fight back the killing pressure of the water by opposing to it the pressure of air forced into the suit by powerful pumps. But there is a limit to the amount of air pressure a man can endure: that limit is approximately the pressure required

to fight back the water at a depth of three hundred feet. If men are to explore the greater depths they must go down clad in armor in itself strong enough to defy the tremendous water pressure, leaving the diver free to breathe air at ordinary surface pressure while he works. Such a suit, the one shown in the reproduction of a photograph above, has been invented by a negro mechanic. A descent of three hundred and sixty feet has actually been made with it.

The diver is ready to adventure in the deeps. The heavy armor will save him from the crushing pressure of the water, but can he do useful salvage work encumbered by this shell of steel?

The Life Story of a Double Calf

A MOST curious freak of nature is this double calf. It has two heads, two pairs of front legs, and two bodies that join each other in an almost straight line. One pair of hind legs jut out from the point where the two bodies meet.

The calf lived and thrived for six months, but then it caught cold and died. The two perfect heads were quite independent of each other. The calf could eat with one or both at the same time, to suit itself.

It was born on a farm near Dayton, Ohio, and its parents were Jerseys. Although it was cared for most tenderly during its six months of life, it grew but little during that period.

As the lady above patted one of its heads, we wonder if the other head was jealous.



Wrecked Aviators Need Not Drown

SUPPOSE that your airship engine stalls over water. Suppose that the hydrogen is depleted. What then? The answer is to be found in a novel life-boat constructed of waterproof fabric, and designed to be inflated by the air-pumps which keep the envelope of a "blimp" rigid in spite of changes in gas volume. On ships of the Zeppelin type such as the R-34 the device is blown up by other means.

When inflated the airship life-boat will support six people until a rescue vessel summoned by the wireless of the wrecked airship comes to the rescue.

Our illustration gives an excellent idea of its general characteristics, though in this case the air-pumps are replaced by a much more attractive kind of inflater.

You Can Have Your Own Gasoline Station

AN automobile owner at Redondo Beach, Cal., became very tired of driving his car around to the garage every little while in order to replenish it with gasoline. Accordingly he had a tank built into the wall at the side of his driveway. You can see it in the above picture.

The tank is of metal, covered with cement. A connection is provided for filling and a float gage shows the amount of gasoline in the tank. To draw off the contents a small pump is used.

The owner has an arrangement with the gasoline distributors to keep the tank filled, and so he has a constant supply.



A Carving of General Pershing Made Out of Soap

THEY'VE photographed General Pershing, made busts of him, painted pictures of him, and now one man has carved his head out of soap!

This may seem queer to you, but if you were a soap salesman, or in fact any other kind of salesman, you would realize the value gained by decorating your product with a likeness of the hero of the hour.

The man who ordered the soap bust of Pershing was a druggist who, like most druggists, sold everything else besides drugs. He filled one window of his store with cakes of soap, placed the soap bust of Pershing in front, and thereby greatly increased his sales.

A Fence that Was Founded in Barrels

"WELL, I hate to take up all those paving-stones, and we certainly can't break through them to make post holes," said the boss, when he and the foreman were discussing the erection of a temporary fence over a portion of a sidewalk.

"M-m, no," replied the foreman; "but

wait, I've got an idea: why not put the posts in barrels and then fill the barrels with something?"

Accordingly the posts that were to support the fence—and a scaffolding later on—were placed in large tubs which were set out at equal distances along the line of the proposed fence. Ashes were brought

from the boiler-room of the factory and the barrels were filled up, holding the posts firmly in place.

When a high slat fence was built on the posts in the ordinary way it afforded perfect protection against intruders. How it looked, inside and out, when it was finished you can see by a glance at the picture.

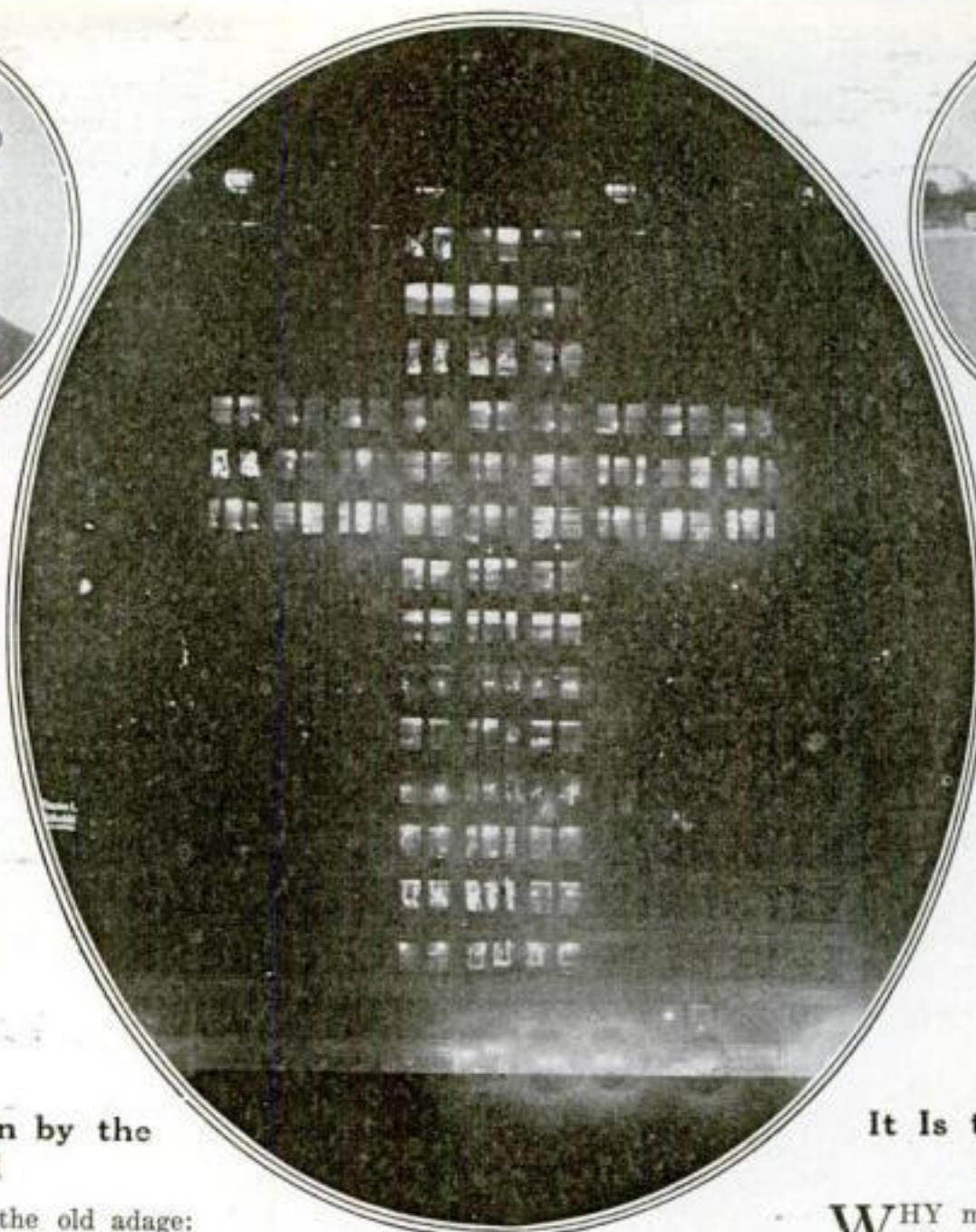




Billiards on a Cigar-Holder

WHEN Mr. Asra, a famous German billiard-player, gets through with the cigar-holder he is using it will undoubtedly find its way into the museum for freak works of art where the gem of the collection is a copy of the Venus de Milo with a clock in her abdomen.

The cigar-holder is six inches long and on it is mounted a small ivory billiard-table at which two men are playing.



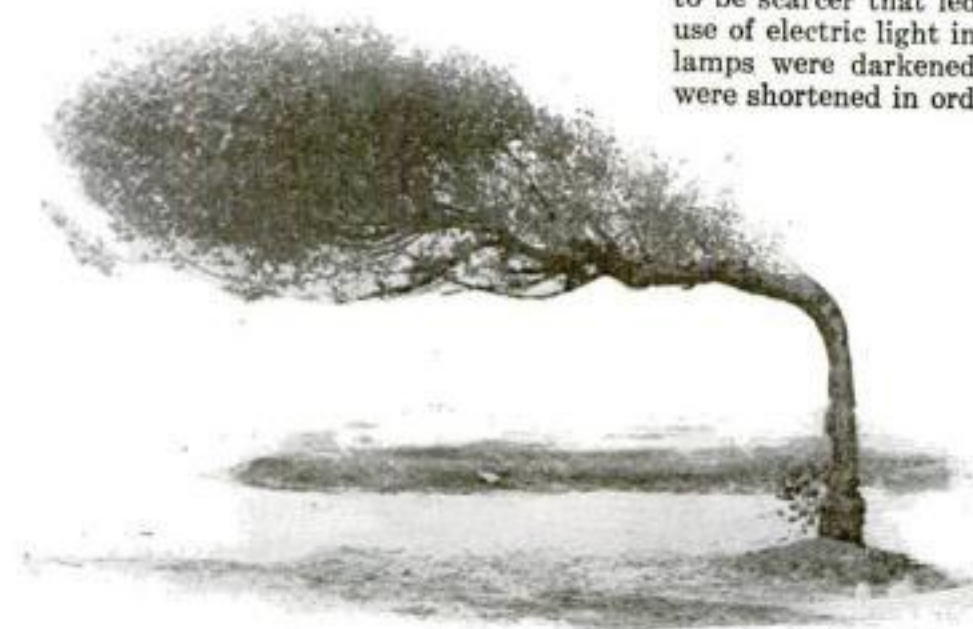
Bent But Not Broken by the Wild Wind

HERE is new proof of the old adage: "As the twig is bent the tree's inclined."

Instead of growing straight upward the tree shown in the picture below grew horizontally after the trunk had attained a height of four feet. The reason for its L formation is the wind.

This tree is situated on an exposed part of a cliff in the Isle of Thanet, England. Ever since it started to grow the sea wind has blown on it from one direction. The tree was not strong enough to stand up against this constant force and so it bent over. In spite of this, the leaves are all doing well, nevertheless.

It often happens that plants and trees incline toward the light when they are located in dark places, but it is seldom that a tree bends over so completely because of the wind.



A Building Lit Up in the Shape of a Cross

SHOULD you approach the Railway Exchange Building in Chicago on a dark and gloomy night, don't be alarmed if you see from a distance a great brilliant cross standing out in front of the building. As you draw near you will see that it is simply the effect of certain lighted rooms against the dark background of the building.

Many of the large office buildings in the Loop district of Chicago have gone in for this artistic illumination. They choose their designs and then light up the rooms necessary for making them.

Perhaps it was this very extravagance at a time when coal was scarce and threatened to be scarcer that led to restriction in the use of electric light in Chicago. The street lamps were darkened and the office hours were shortened in order to save coal.



Drinking at the Fire Hydrant

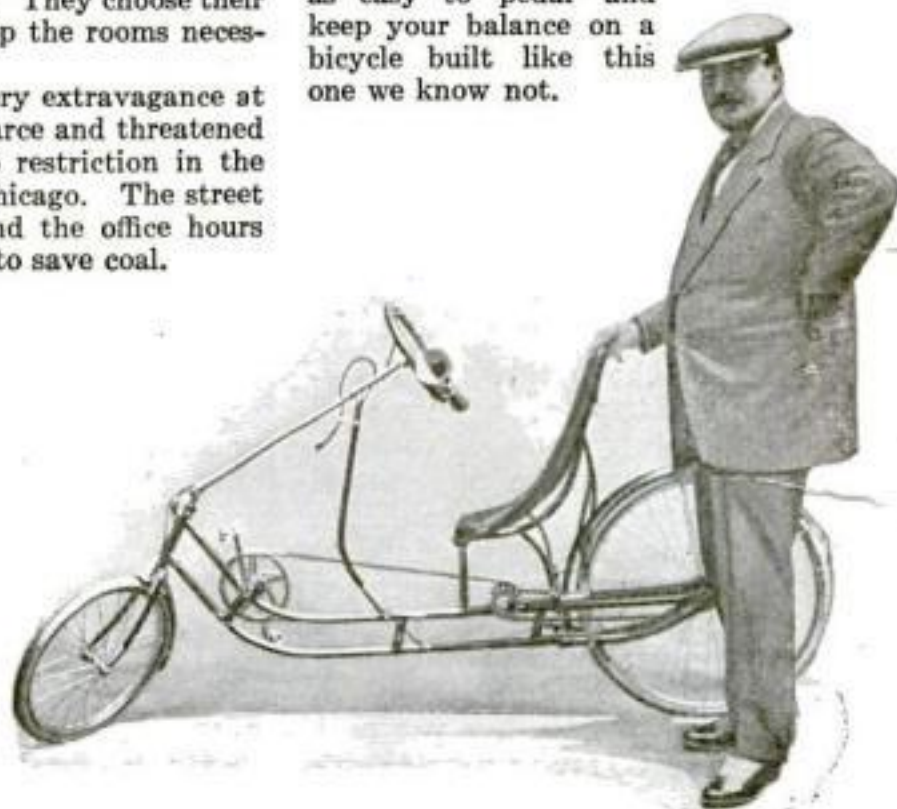
THE fire hydrants in the town of Torrance, Cal., have great white porcelain bowls erected on their tops. And when there are no fires in town the natives gather around these pumps and drink. For the bowls are regular drinking bowls into which a constant flow of water is forced.

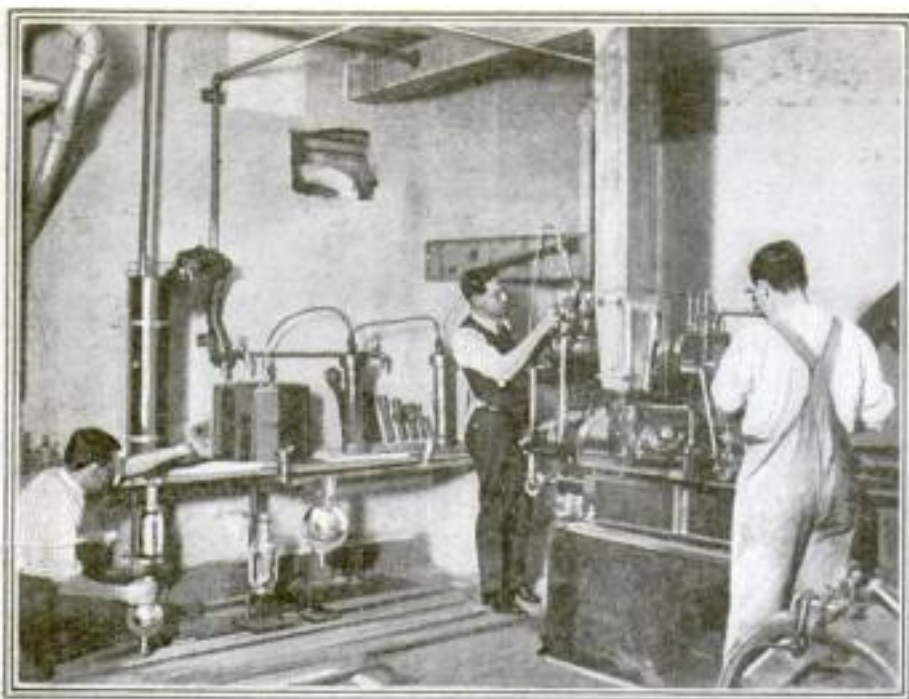
To install one, a hole is drilled in the top of the cap of the hydrant and a one-inch pipe is connected with the water-pipe below.

It Is the Limousine of the Bicycle World

WHY must a cyclist sit up straight, flivver fashion, when he rides? An uncomfortable Parisian cyclist asked himself this question, and answered it by building the bicycle shown below. It contains most of the comforts of an automobile driver's outfit. The seat itself is low and has a supporting back; instead of handle-bars there is a steering wheel with a horn mounted on it. The pedals are not directly below the seat but are up near the front wheel.

This front wheel, by the way, is smaller than the usual bicycle wheel, the reason for this being to make room for the long sloping steering wheel. Whether it is just as easy to pedal and keep your balance on a bicycle built like this one we know not.





At the right, compressing air; in the center, admitting it to the cooling tubes; at the left, drawing off liquid air

Making Liquid Air

AIR is invisible, says Webster's dictionary. Not always. Air can be turned into a liquid, whereupon it becomes quite visible. First, the air is compressed to three thousand pounds per square inch, which is about two hundred times as great as ordinary atmospheric pressure. Then it is cooled off in tubes until its temperature reaches three hundred and ten degrees, Fahrenheit, below zero. At this point it becomes a liquid.

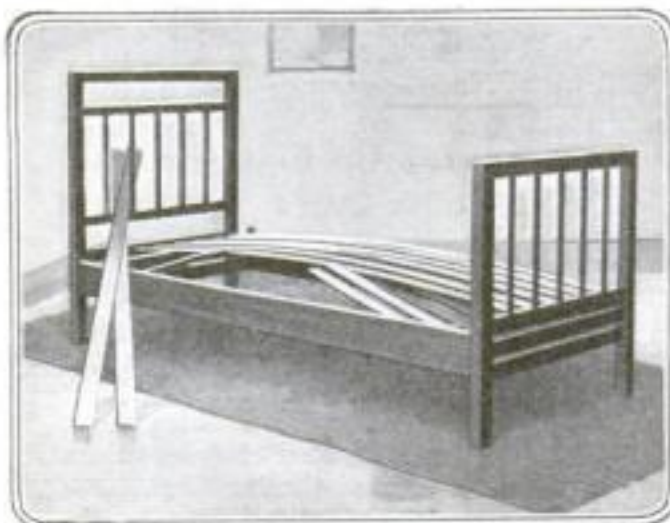
Liquid air is used both in scientific research and in industry. In research work it is used for cooling; the substance is immersed in the liquid air and watched to see how it acts at low temperature. In industry liquid air is used to produce pure oxygen. Air is composed chiefly of oxygen and nitrogen, and owing to the different boiling points when liquefied they can be separated.

The Price of a Zeppelin Ride

THE value of the German mark sinks lower and lower. You can buy about forty of them for an American dollar now. Thus should you buy a dollar's worth and go to Germany, they would be worth nearly ten dollars over there, and you could buy ten dollars' worth of goods with them.

The Swiss, living next door to Germany, take advantage of this depreciation in mark value. A regular Zeppelin service from the Swiss border to Berlin has been running now for several months. The Swiss buy their tickets with German marks and thus the trip becomes a very cheap one. The Zeppelin makes the trip three times each week and it is always well patronized. This is due not only to the low value of the mark but also to the poor condition of the railways in Germany today.

Still, the owners of the Zeppelin are making money by it. They figure that in the first two years they will take in enough money to pay for the Zeppelin and then have a twenty-five per cent profit left over. So far no repair work has been necessary.



To a wounded soldier there was comfort in the idea of a bed that wouldn't sag

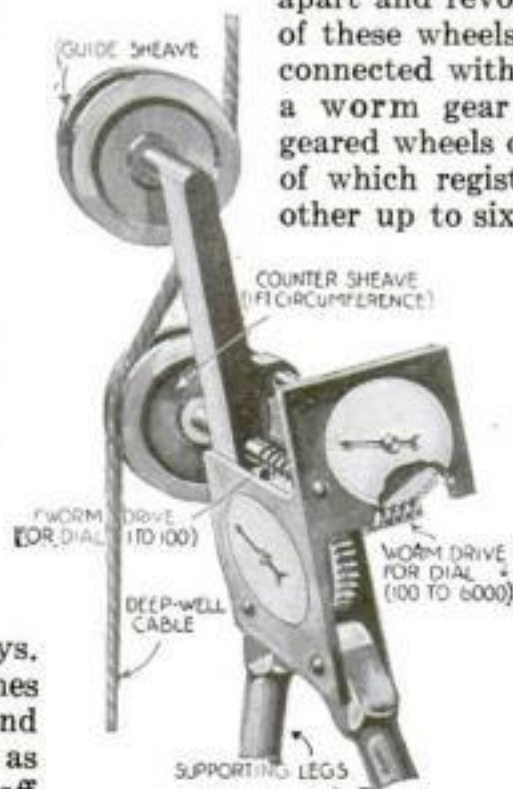
A Wooden Bed-Spring

WHILE lying wounded in a hospital, a French soldier named Delacourt found that his bed was developing hills and valleys from supporting his weight so long in one place. His solution of the problem is shown above.

Long springy slats are inserted tightly between head and foot boards, arching upward from the ends, every slat above having a companion slat below arching downward so that each pair forms an oval. A second set, similarly arranged, run crosswise of the bed-frame.

To Measure the Depth of a Well

An ingenious apparatus for measuring the depth of wells or mine shafts is a dial indicator actuated by a worm gear, the invention of Charles A. Wilkins of Bradford, Pa. This measuring device contains two grooved wheels several inches apart and revolving in the same plane. One of these wheels is an idler, while the other is connected with the measuring mechanism by a worm gear which sets in motion the geared wheels of the two indicating dials, one of which registers up to one hundred, the other up to six thousand feet.



Place the grooved wheels against the cable, let the cable run up or down as far as it will go, and read off the distance on the dial

Look Out, Below!

A SHARP blow on the back of the head with a heavy lead pipe—that ought to knock out anyone no matter how thick-skulled he may be; and yet the man in the picture below doesn't seem to mind it in the least.

Why not? He wears a shock-absorbing cap sufficiently thick and resilient to absorb most of the force of the blow. It has many air holes, so that the hair of the wearer is well ventilated.

The cap was not designed for men who walk down lonesome alleys on dark nights, but for miners, builders, tunnel-diggers, and others who are constantly in danger of having something heavy dropped on their heads.

The shock-absorbing cushion is circular in form and fits inside the cap.



A blow on the head with a lead pipe usually means trouble, but in this case it simply proves the excellence of a shock-absorbing cap

What the Handy Man Can Do with an Old House

By George M. Petersen



IT is undoubtedly true that many American houses are as the first occupants left them, because the owners are living in the hope that some day in the dim future they may be able to build a bigger and better one, and are consequently loath to expend any money on remodeling the one they now have. This is a mistaken and foolish idea for various reasons. The old home can be remodeled satisfactorily without any great expenditure and will last for many years to come.

It is, therefore, with the idea of being of some real assistance to our readers who are progressive enough to want to keep their property up-to-date that we are publishing this article on remodeling.

The style of house that we have chosen for consideration is the old-fashioned one-story cottage, which is just as it was fifty years ago with the exception that the outhouse has been abolished and a toilet installed in a closet

off of the kitchen. Of course this was really an improvement in some respects, but hardly one which can be considered to be really up-to-the-minute from a sanitary point of view. The plan with which we shall

work is shown in the drawing captioned Original Plan (page 92).

It will be noted that aside from the rather poor arrangement of rooms the rooms themselves are poorly lighted, a common fault with the typical old house of this type. In this regard it may be well to mention that no matter what else you do when remodeling your house do not fail to get sufficient light and ventilation.

In Solution No. 1 we have modernized the house, to a certain extent at least, by merely moving the old pantry partitions and building in a bath-room which is easily reached from either of the two bed-rooms. Although this step does not appear to be very drastic it is really very important, as for very small expense the property has been made fully one hundred per cent more desirable.

Solution No. 2 has proceeded another step in the right direction and the partition between the reception hall and parlor has been removed so that a large modern living-room has been obtained. This move is especially desirable because it gives one the impression that the house is an up-to-date bungalow instead of an old house remodeled. The back parlor has given way to the dining-room, while the old dining-room has been partitioned off into a hall and office. This is really an excellent solution of the problem which confronts so many persons today—how to have an office right in the home which will look businesslike without going to excessive expense.

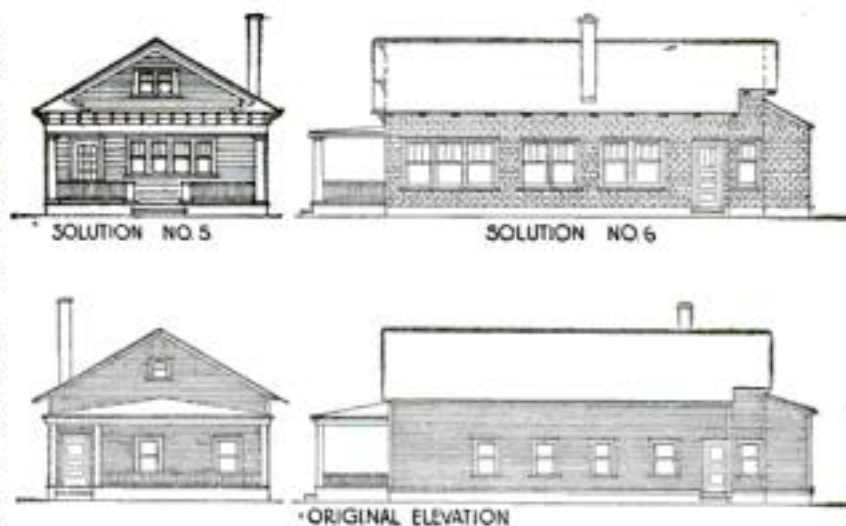
This article is published with the idea of offering assistance to those of our readers who want to keep their property up-to-date. Any questions that may arise in the reader's mind will cheerfully be answered by the author free of charge, if a letter is forwarded care of the POPULAR SCIENCE MONTHLY with a stamped envelope enclosed for reply.—EDITOR.

Solution No. 3 has gone another step in the right direction and brought the kitchen location into juxtaposition with the dining-room. This latter room has been made a trifle narrower and a little longer in order that clothes closets, linen closet, and hall may be incorporated into the scheme. Here, again, the young professional or business man may have his office without in any way interfering with the home section of the house. If an office is not required the room may be used as a den, or it will make another excellent bed-room so that the house will then possess three chambers.

Solution No. 4 leaves the entire rear part of the house just as it was in Solution No. 3, but the front part has been altered so that the two side chambers are greatly enlarged. Of course the living-room suffered a little in size as the result of this move, but this fault, if it may be so termed, is readily overcome by the legitimate use of a large-cased opening between the living-room and the dining-room, which



Here the front part of the house has been altered, so that the two side chambers are greatly enlarged



Above, the house covered with narrow siding; below, the same house covered with shingles

allows them to be thrown together as practically one room if a large party is expected.

This is the same idea as the one shown in Solution No. 3. One may consider the living-room and dining-room as two rooms, though in reality they are only one. In this instance the idea was to convert the space across the front of the house into a music-room and a living-room by just showing the suggestion of a partition between them. This cased opening problem is worthy of considerable thought upon the part of the owner, as it is often easier to furnish two rooms than it is to furnish one large one.

Of course, any of these plans or

solutions may be carried further by the addition of a fireplace in the living- or dining-rooms. Hardwood floors throughout the house, built-in bookcases, china cabinets, kitchen dressers, linen closets, and many other features of a like nature will greatly add to the beauty and comfort of your remodeled

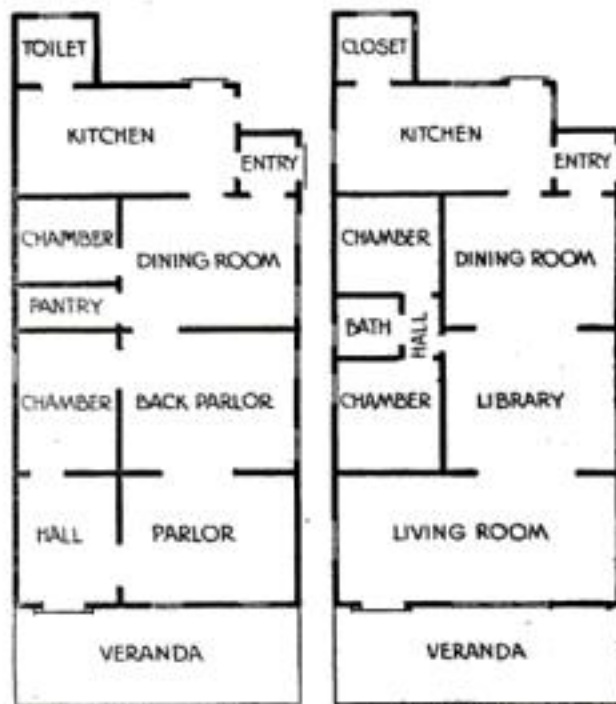
house. This alteration is especially adapted to the plan shown in Solution No. 2, although it would look well with almost any window layout. The plain gable cornice has been replaced by a very wide barge board and heavy moldings, and the main cornice has been carried across the front of the house. This cornice is supported by medium weight brackets and the whole tendency of the elevation is to make the building appear heavy, solid and massive.

The small balusters shown in the veranda rail on the old elevation have been replaced with one and three quarter inch square pickets which are placed between heavy top and bottom rails. The veranda columns and newels are slightly tapered, instead of being perfectly straight as in the old elevation and the pitch of the roof has been altered so that it is now sloped toward the front of the house to allow for the cornice return across the front of the building.

The small window in Solution No. 5 also helps to set off the house, but casement windows are not recommended by the writer. Use double hung or check sash windows, as they are commonly termed, and reduce the size of the glass in order to get them into a given opening rather than install the larger glass and a casement sash.

The main reason for this statement is the fact that it is almost impossible to make casement windows tight unless a comparatively large amount of money is expended upon each individual window for patented weather-strip, and then the results are usually far from satisfactory. It is therefore best to stick to the double hung windows and cut the upper sash into three lights as shown in the drawings or some other design which will suit the artistic ideas of the owner.

The side elevation shown in Solution No. 6 is of the same house covered with shingles, instead of the old narrow siding, and was designed to work with the plan shown in Solution No. 4. This side elevation allows a great quantity of light and ventilation in the house and, as has already been mentioned, too much of either of these



ORIGINAL PLAN

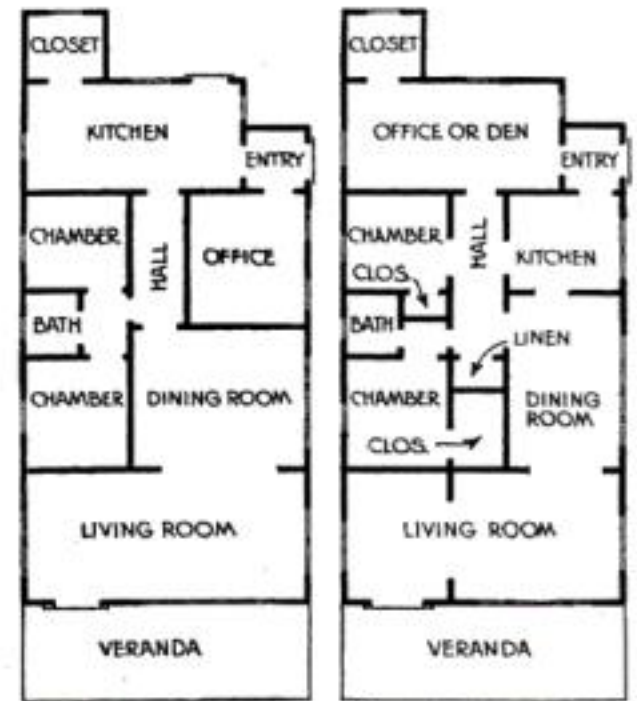
SOLUTION NO. 1

Remove the old pantry partitions and build in a bath-room opening conveniently into the two bedrooms

house, but such things are not actually essential and may be put in at any time without any great additional expense.

Of course the remodeling need not end with the interior, but may be continued to the exterior as well with excellent results. The Original Elevation (page 91) shows the exterior of a house of this type and a little study will convince anyone how readily it lends itself to modern ideas.

The front elevation shown in Solution No. 5 is a typical bungalow type and is very desirable for this style of



SOLUTION NO. 2

SOLUTION NO. 3

By a little planning, the reception hall and parlor may be transformed into a large living-room

items cannot be obtained. In this elevation the gable is shown supported on five heavy brackets, while the main roof cornice is blocked up on lookouts.

It is certainly a fact that building materials are high priced at present but that is all the more reason why people should do their building and remodeling now instead of waiting for prices to come down, as all material is going up, not down, and there is little doubt but that it will remain up at its present price, or even higher, for some time to come.

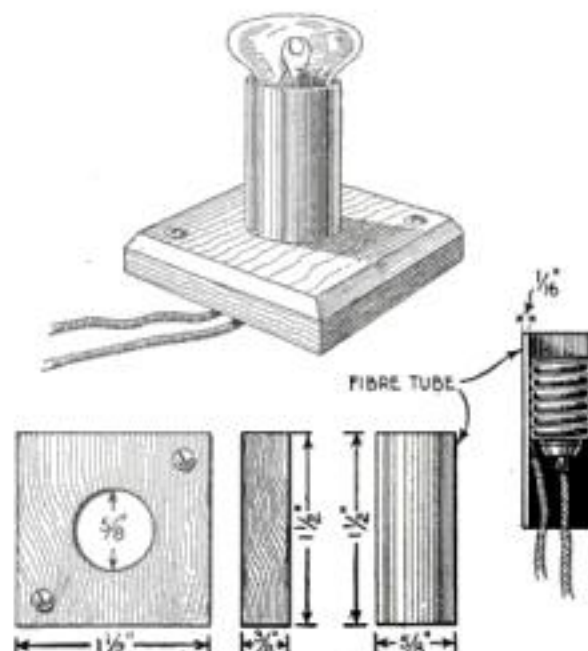
If You Wish to See Your Phonograph Records at Night

By H. E. Mende

WHY scratch and damage your expensive phonograph records? You can install a miniature electric light in a very few minutes, so placed that it will illuminate the record while at the same time leaving the room in darkness.

Obtain a piece of hardwood and cut a piece from it $\frac{3}{8}$ by $1\frac{1}{2}$ by $1\frac{1}{2}$ in. Drill a hole in the center $\frac{5}{8}$ in. in diameter, also two small holes in each side, to be used for screwing it to the motor-board; then bevel the edges. Now get a piece of fiber tubing $\frac{5}{8}$ in. in diameter with $\frac{1}{16}$ in. wall and $1\frac{1}{2}$ in. long. This piece is to be glued into the $\frac{5}{8}$ -in. hole in the center of the base.

Purchase a keyless receptacle for the miniature screw base bulb, and break loose the cement to take out the brass threaded sleeve and the bottom screw; then solder a piece of thin insulated wire to the brass thread



This illustration shows the entire mechanism before and after assembling

sleeve and one also to the bottom screw.

Now the parts are ready to be assembled in the fiber tubing, which must be fastened in place with plaster-of-paris. Be very careful not to have these two parts of the wires touch, since that would, of course, cause a short circuit.

The light is now finished. The next thing to do is to determine the best place to install the light, where it will not interfere with the working parts of the phonograph. When this is settled, drill a $\frac{1}{8}$ -in. hole through the motor-board, and screw the light in position. Place the batteries in the bottom of the machine and connect the wires.

The correct bulb for one battery is 1.5 volts. The bulb takes the place of a switch, which lights when it is screwed down and goes out when it is loosened.

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The Result



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Noon, Third Day



Seventh Day



Twentieth Day



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Complete Material for Immediate Shipment

Aladdin taps the four greatest forests of the United States. Each one has sufficient standing timber to take care of the needs of the country for many years. The probable lumber famine predicted in all parts of the country will not affect the Aladdin Co. Every Aladdin house ordered in 1920 will be shipped quickly and *completely*. Sufficient lath and plaster for lining the interior of the home. Nails in necessary sizes and quantities. Beautiful grain, perfect quality interior trim. Doors of high quality material and excellent workmanship. Every item of the complete home will be promptly shipped to every Aladdin purchaser in 1920, regardless of shortage of lumber and other building materials in the general markets.

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Shipments of Aladdin Readi-cut Homes are made from the four greatest timber-producing sections in the United States. From the Atlantic to the Pacific—from Canada to the Gulf—Aladdin can serve you wherever you live. Aladdin houses are manufactured and shipped direct from the Aladdin Company's own mills in Michigan, Mississippi, North Carolina and Oregon. Aladdin houses come to you in a straight line from the nearest timber region. Complete Sales and Business Offices are maintained in connection with each mill. Fully 24 hours time is saved in your mail reaching our offices.

20 ft. of Lumber from a 16 ft. Board

The Aladdin System of Homebuilding has been practicing for 14 years the principle the world has only learned during the war—the elimination of waste of lumber and labor. The Aladdin Book explains this system thoroughly, shows how 20 feet of lumber is cut from a 16 ft. board. The great Aladdin Organization, composed of experts in every branch of homebuilding, stands ready to help you build your home at a saving. Put this group of experts to work on your problem.

Send for Interesting Book "Aladdin Homes"

The Aladdin Book of Homes has a message for you. Amongst its pages, profusely illustrated in colors, leading home designs are represented to you. Aladdin houses are cut-to-fit as follows: Lumber, millwork, flooring, outside and inside finish, doors, windows, shingles, lath and plaster, hardware, locks, nails, paints, varnishes. The material is shipped to you in a sealed box-car, complete, ready to erect. Safe arrival of the complete material in perfect condition is guaranteed. Send today for a copy of the book, "Aladdin Homes," No. 1372.



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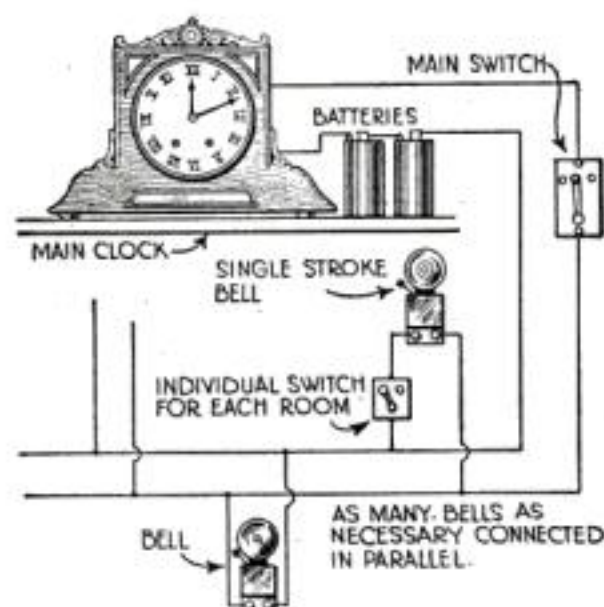
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How to Make All the Clocks Strike at Once

By L. B. Robbins

IF you have ever lain awake in the night and listened to several clocks trying to strike in time with each other, with a syncopation which reminded you of a jazz band or an Oriental funeral procession, you will appreciate the following device to eliminate such ragtime and make Father Time walk the straight and narrow path. The idea consists of utilizing the best timekeeper in the house as the central station and electrically transferring the impulse of its strike to bells in the various rooms of the house. In this way the hour is struck by each bell at precisely the instant it is struck



The whole contrivance is operated by the master clock

by that of the central clock, and there will be no guesswork as to the time.

The general arrangement is shown in the drawings with such detailed sketches as are necessary to make the operation plain.

The first requisite is a clock that strikes the hour and half hour. The style of striker is immaterial so long as it consists of a lever, pivoted somewhere along its length, one end of which connects with the striker wheel, the opposite end striking the gong. By studying the detailed sketch of the striking apparatus this will be clearly seen. Styles and shapes of levers may

vary, but the principle remains the same.

Select a narrow strip of very thin, flexible metal, which will give under the slightest pressure but will return to its original shape when the pressure is removed. If the lever can be conveniently removed from its position in the clock, this piece of spring metal can be soldered to the lever close to the pivot hole. If not it can be clamped to the lever, in this position, with fine wire. The extending end should be doubled under, as shown, to gain greater flexibility. Bend it so that its relation with the side of the clock is about as indicated.

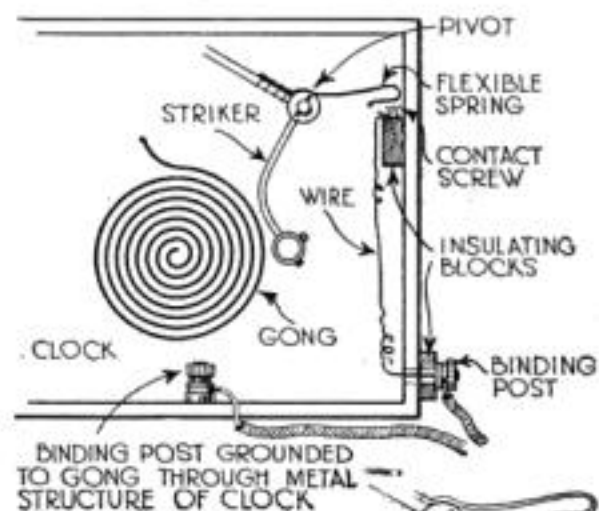
Directly under this spring place a block of wood, fiber, or rubber, into which a screw is inserted. The block serves to insulate the screw from the clock frame or any metal parts. Connect the screw to an insulated binding-post, at a convenient point, with insulated wire. Then bring the head of the screw to within a fraction of an inch of the spring strip. The distance should be adjusted so the strip will come into good contact with the screw when the hammer of the striker is in contact with the gong, but so that there is good clearance between them when the hammer is back at its resting-point.

A second binding-post should then be connected to the metal framework of the clock. Be sure this has metallic connection with the gong. This completes the alterations to the clock.

Wire the house bells in parallel as shown. Provide each bell with an individual switch, so that it may be

cut out if necessary. This, owing to the method of wiring, will not prevent the other bells from striking with the clock. A general switch near the clock serves to cut out the entire system if so desired.

Use bells with a single stroke action.



The style of clock striker is immaterial so long as it consists of a lever

DETAIL OF CONTACT SPRING

These will give the best results as the time of contact of the gong switch is so brief that it would have little effect upon the vibrators of the bells.

If no single stroke bells can be readily procured common vibrator bells can be changed to single stroke action by disconnecting the wiring from the vibrator adjusting screw, and transferring it directly to the magnet windings by means of the off binding-post. Thus, when the coils are magnetized they pull the armature to them, but release it the instant the current is shut off. The spring at the foot of the armature serves to return the hammer to its former position.

If the builder wishes, he can make brackets to hold small bells of more conventional pattern, and utilize the magnets and equipment of call bells. The working parts can be hidden from sight by neat little boxes built around them. One's own ingenuity will suggest many artistic ways in which these striking bells can be disguised.



The bells can be made ornamental and the working parts hidden

Handling Electrical Circuits in Safety

CCARELESSNESS in handling electrical circuits is the cause of many fatalities. Electricity may endanger the life or seriously maim the person who works on live wires in a careless manner. Serious results may be the consequence of direct contact, causing burns, severe shock, and, in many cases, instant death. A flash or an arc may endanger the eyesight, besides being the cause of severe burns.

A shock is the result of touching wires of opposite polarity, or of cutting oneself into the circuit, or of touching a one-line wire and making a connection through the body to the ground. Provided one is per-

fectly insulated from the ground, he may safely touch one bare wire. A person should never trust a system of wiring, since a ground may come at any instant and endanger life. In handling live wires, the following rule is safe to follow:

Use only one hand at a time; keep well insulated from the ground, and from wires having opposite polarity.

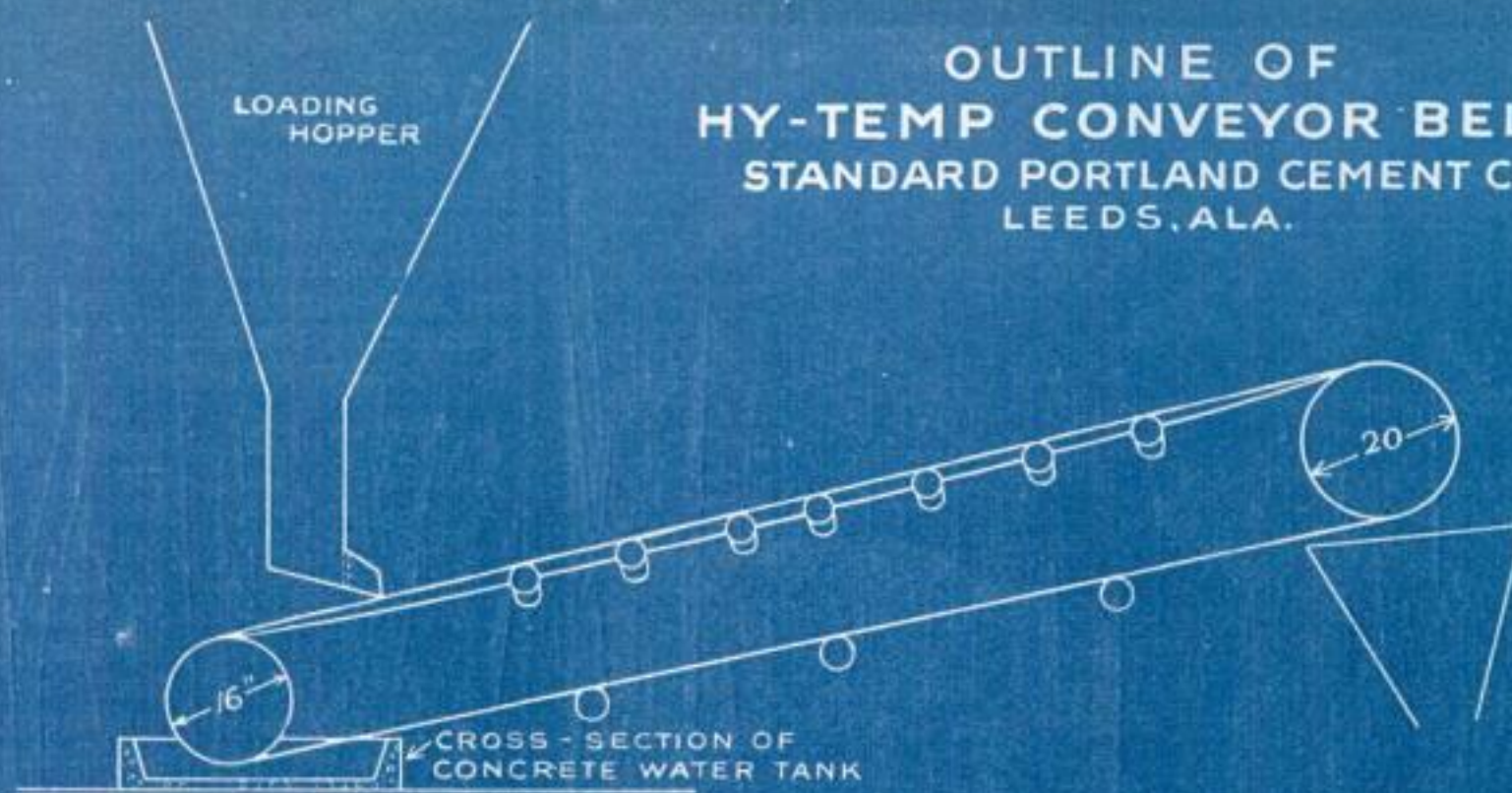
The severity of a shock depends primarily upon the circuit voltage and the degree of contact made with the live wire. Contact varies with the condition of that part of the body that touches—whether dry or moist; and with the quality of the ground

connection through the body. It is not always safe to touch a live wire of low potential, nor is it always fatal to make contact with a high-voltage circuit.

Danger to the eyesight and from burns is caused usually while fusing a circuit, or while throwing in or out switches on circuits carrying heavy currents. Carelessness in handling live-wire ends may cause a short-circuit and consequent injurious flashes.

Carrying too much current will cause wires to become overheated. Broken circuits cause an arc which may communicate fire.

OUTLINE OF HY-TEMP CONVEYOR BELT STANDARD PORTLAND CEMENT CO. LEEDS, ALA.



Specified GOODYEAR HY-TEMP
CONVEYOR BELT 16" 5 PLY.

TOTAL LENGTH 72'-2"
HEAD PULLEY 20" x 18" TAIL PULLEY 18" x 18"
6 TROUGHING IDLERS UNEQUALLY SPACED
TOP COVER 1/8" PULLEY SIDE 1/16"
CRESCENT FASTENERS USED
F.P.M. 196.3 T.P.H. 60 TEMP 200° UP
MATERIAL DELIVERED 30" FROM TAIL
POWER DELIVERED AT HEAD PULLEY
LUMPS VARY IN SIZE FROM 1/4" to 5"
ANGLE OF INCLINATION 12°

Copyright 1920, by The Goodyear Tire & Rubber Co., Akron, O.

Hot Clinker, a Conveyor—and the G.T.M.

Hot cement clinkers, 200° and over, to be carried from open storage to the grinding mills, were the crux of the conveying problem put up by the plant superintendent to the G. T. M.

The G. T. M.—Goodyear Technical Man—gave that situation expert study embracing every process in cement manufacture at the plant of the Standard Portland Cement Co., Leeds, Ala. He realized that here was an unusual problem. The clinker could not be cooled sufficiently in the processes previous to conveying. The best thing to do would be to provide some means of cooling it as it came onto the belt.

So he made two recommendations: a heat-resistant Goodyear Hy-Temp Conveyor Belt, known to be capable of withstanding as much as 200°; and a cooling vat through which the belt might run as it struck the tail pulley and come up dripping with a film of cold water that would cool the clinker dropping from the hopper. Both recommendations were approved.

Up to September 1, 1919—after six months of operation—this Goodyear Hy-Temp Conveyor had carried 61,000 tons of clinker. The Standard

Portland Cement Co. credits a saving of \$300 in belt cost alone to this Goodyear Conveyor. Besides, it has effected a high operating economy. A letter from them states that the Company is "so pleased with its performance that we have ordered a duplicate for replacement, although from present appearances this belt will continue to give good service for some time."

Wherever heats up to 200° are registered on conveying jobs, in mines, in coking plants, in cement factories, Goodyear Hy-Temp Conveyor's special construction sets up new records in heat-resistance, ability to withstand abrasion, and quantity of tonnage delivered.

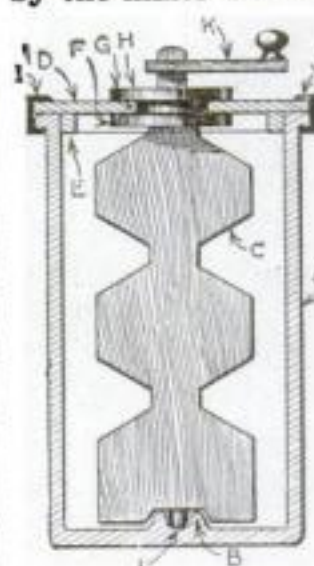
Working with your own plant superintendent, the G. T. M. can make an analysis that assures intelligent specification of the belt to the duty required. The G. T. M.'s services are yours without charge or obligation. If his suggestions and the Goodyear Belt he recommends prove as valuable in your service as in the instance cited here, and in hundreds of similar cases the country over, our return will be amply guaranteed by your satisfaction.

THE GOODYEAR TIRE & RUBBER COMPANY
Offices Throughout the World

BELTING · PACKING HOSE · VALVES
GOODYEAR

An Inexpensively Made Chemical-Mixer

A CERTAIN manufacturing company recently found it necessary to have a small capacity mixer for chemicals which would do away with metal parts as much as possible, the chemicals being of such a nature that they would eat the metal away. After some experimenting the difficulty was solved by the mixer here described.



Here is a chemical-mixer with parts made entirely of wood. Clamps hold the mixer in place

A ten-gallon crock, A, was purchased which had a cuplike receptacle, B, in the center of the bottom as shown in the illustration.

A wooden paddle, C, was made from wood cut from one piece. The cover, D, which had a flange, E, on the inside was made, and a revolving collar consisting of three pieces, F, G, H, nailed together, was fitted upon it. The cover with its collar was held firmly in place by clamps, I and J. The top of the paddle extended up through a hole in the revolving collar, and a crank and handle, K, was then fitted on. The bottom of the paddle was cut with a kind of round knob L which fitted into B.

When the crank was turned the paddle and collar revolved together, the cover acting as guide and holding everything in place with the clamps.—ALBERT E. JONES.

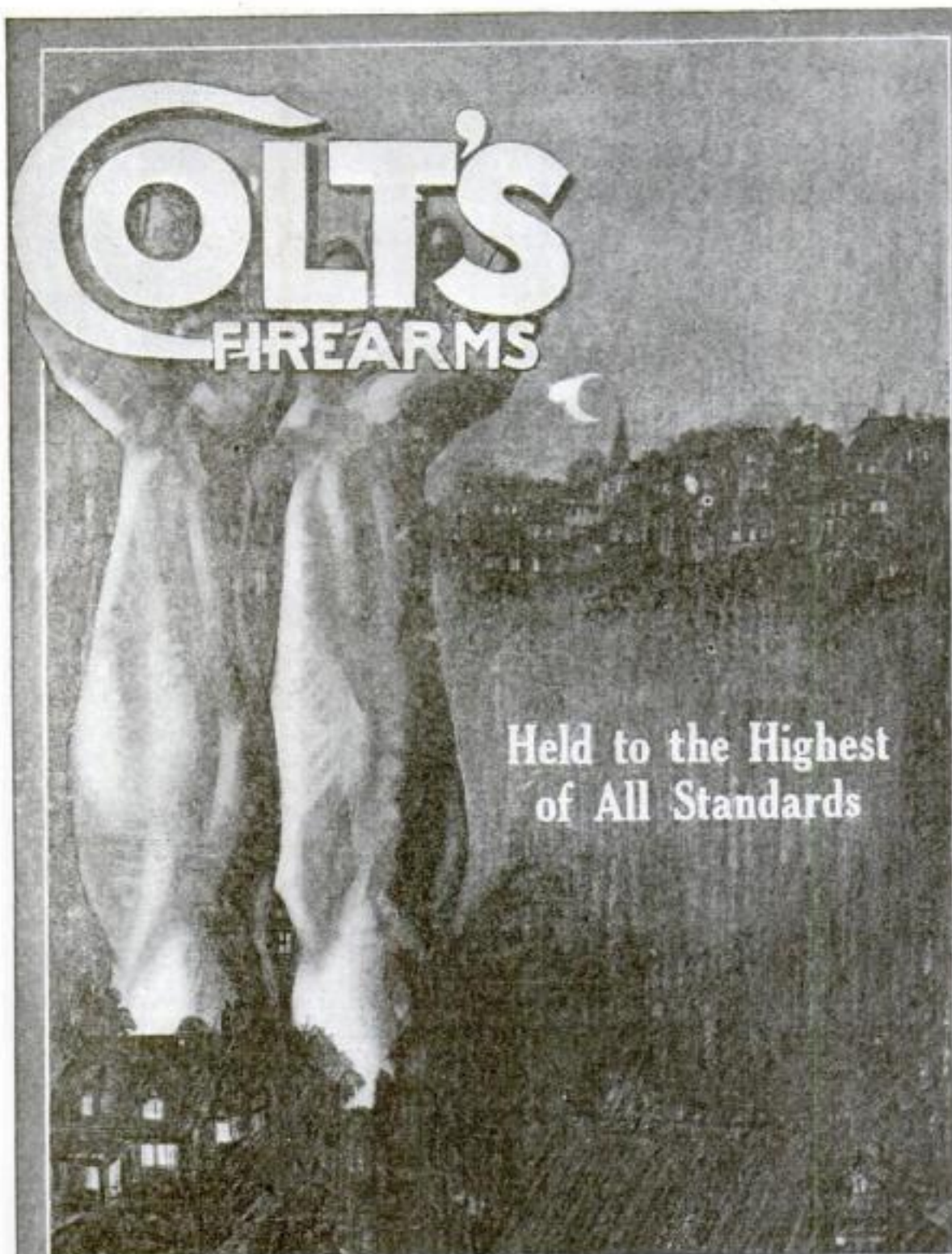
Make a Medicine-Dropper from the Stopper

OFTEN it is very necessary to measure medicine by drops, and not infrequently the medicine-dropper is mislaid or broken.

The cork medicine-dropper has advantages all its own, for it is a part of the bottle and the time saved over the old method of first filling, then expelling the liquid from the patent dropper, is considerable.

The cork stopper fitted in the medicine bottle is used. Cut a groove from the bottom to the top of the cork, about $\frac{1}{8}$ in. deep and half as wide, then put the stopper back into the bottle.

If the stopper does not drip properly, take your jack-knife and deepen the groove still further. The exact size of the groove will depend somewhat on the quality of the cork, how tightly the stopper is fitted into the bottle, and the character of the liquid contents. Once having tried this method, you will not be likely to resort to the old.—J. T. BARTLETT.



Master Craftsmanship

Your home needs this same Colt protection—the protection of “the world’s right arm.” For now that the Colt is back in Civilian Service you do not need to accept a “Second Best.”

NO handiwork of man possesses a finer degree of mechanical exactness, a nicer precision of working parts, a more compact strength than the creation of the master gunsmith—And to have maintained unquestioned leadership for over eighty years—keeps step with every advance of an inventive age—the return made by the great Colt factories to a trust imposed by Government request.

Since its adoption in 1911, the Colt Automatic Pistol, caliber .45, has been the official side arm of our Army, Navy and Marine Corps and with them did its “bit” overseas.

COLT'S PATENT FIRE ARMS MFG. CO.
HARTFORD, CONN., U. S. A.

Manufacturers of
Colt's Revolvers
Colt's (Browning) Automatic
Machine Guns
Colt's Automatic Pistols
Colt's (Browning) Automatic
Machine Rifles



Trade Mark
Reg. U. S. Pat. Off.

How fast does a truck wear out?

If a truck were jacked up off the ground and the engine merely used to transmit power to some machine, it would take years to wear out the motor.

It isn't the running of a truck engine that wears it out. It's the pounding it gets from road shocks.

The life of a truck is very largely dependent upon the resiliency of the tires it rides on. Fleet-owners who have put Kelly Caterpillars on their trucks tell us that the trucks now spend their time on the road instead of in the repair shop.

The reason is simply that Kelly Caterpillars have an unusual depth of rubber and a system of side vents that doubles their resiliency.

Kelly-Springfield Tire Co.

GENERAL SALES DEPARTMENT

4614 Prospect Ave., Cleveland, O.

Protected by
U. S. Patents
June 28, 1904
Aug. 31, 1915
Mar. 14, 1916
Feb. 19, 1918



KELLY SPRINGFIELD TRUCK TIRES

United States SAND PAPER

**Sand Paper
is NOT made with sand**

**Fast-Cutting
Mineral Abrasives**
On cloth and paper
Flint Paper
Garnet Paper Garnet Cloth
Emery Paper Emery Cloth
Crocus Cloth
Carbalox Cloth
Herculundum Cloth
*Sheets, Discs, Circles, Belts and Rolls
of various widths and lengths of the
above U. S. Abrasives.*

Sand is round; it will not cut. Sand paper is a *cutting tool*. Like other tools, it must have that which corresponds to temper; must hold a cutting edge.

Good sand paper is made by us from Nature's whitest flint rock or the reddest garnet, crushed, sifted to different finenesses and everlastingly glued to strong cloth or tough fibred paper especially made for the purpose. Other U. S. abrasives are from the fiery electric furnace; remarkably tough, and hard enough to cut metals: these are known as Herculundum and Carbalox. For cast iron and similar materials, Herculundum is ideal.

Carbalox is best for steel, brass, copper, aluminum, etc.



A disc grinder using U. S. flint or garnet paper smooths wooden things up in a jiffy. Disc grinders are made in various sizes; horizontal and vertical types.

In modern woodworking plants U. S. Sand Paper—flint and garnet—are used in sheets and convenient width rolls for fine hand finishing work. Here, actual belts of sand paper running at high speed, quickly whisk the roughness from irregular pieces. Rolls of sand paper on drums smooth up rough doors, sashes and other flat work. Discs of U. S. garnet paper on rapidly revolving wheels bite rough spots off quick as a wink.

In foundries and machine shops, discs of Carbalox and Herculundum are doing fine finishing work formerly handled by planers and milling machines at great saving of time and labor. Get all the facts on this.

Everywhere, in all industries, the map trademark of the United States Sand Paper Co. is known as the mark of dependable abrasives—of quality that does not vary.

Buy your abrasive papers or cloth as you would fine tools. Our Service Department will study your requirements and recommend the grades best suited to your work. Tell us whether you work on wood, metal, leather or composition materials.

UNITED STATES SAND PAPER COMPANY
Williamsport, Pa.



Why tear a sheet of sand paper to get a small piece? For convenience and economy, use U. S. Sand Paper in rolls of various grits, widths and lengths.



U. S. Emery, Carbalox and Herculundum in rolls of various widths and grits should hang above the bench of every metal worker. Saves time; more economical.



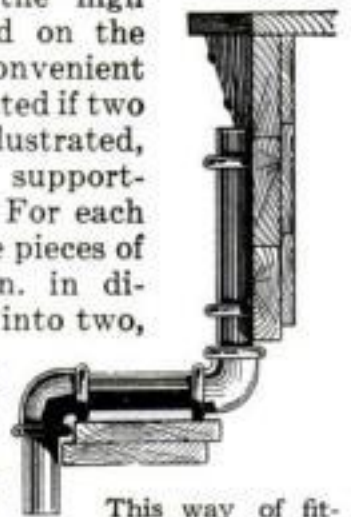
Discs of Herculundum and Carbalox glued to horizontal or vertical wheels are great time savers in finishing castings and forgings to fit. The discs last long, both cloth and grit being just right for the work at hand. Write for the complete story on this.



Pipe Brackets to Support Bottom Boards of Wagon

ORDINARILY, in dumping a wagon, the bottom boards must be lifted over the high sides and placed on the axles. This is inconvenient and can be obviated if two brackets, as illustrated, are made for supporting the boards. For each bracket use three pieces of pipe, about 1 in. in diameter, screwed into two, 90-deg. elbows.

In this way a convenient ledge is formed on which to place the boards.—E. W. BUERSTATTE.



This way of fitting wagon sides doubles the load

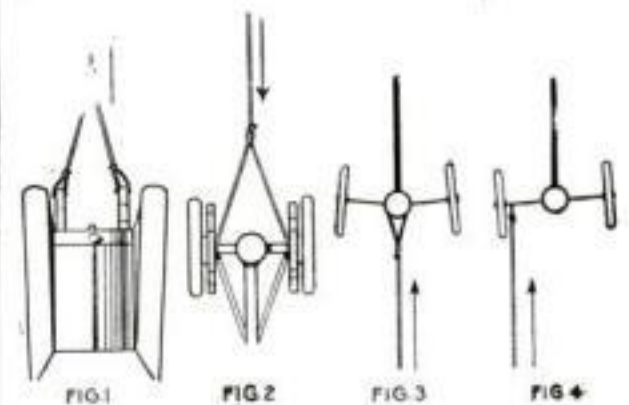
Towing a Disabled Car Without Injury

THE automobile that makes a business of towing disabled cars, as a rule, does not last long. Generally the main cause of their rapid destruction lies in improper fastening of the tow-lines.

The car being towed does not receive injury if the tow-rope is fastened to any part of sufficient strength to withstand the pulling strain. Still, it is better to attach the tow-rope to both ends of the frame, as in Fig. 1.

The nearer the fastening is made to the traction points of the towing car, the less strain the towing-car will have to undergo.

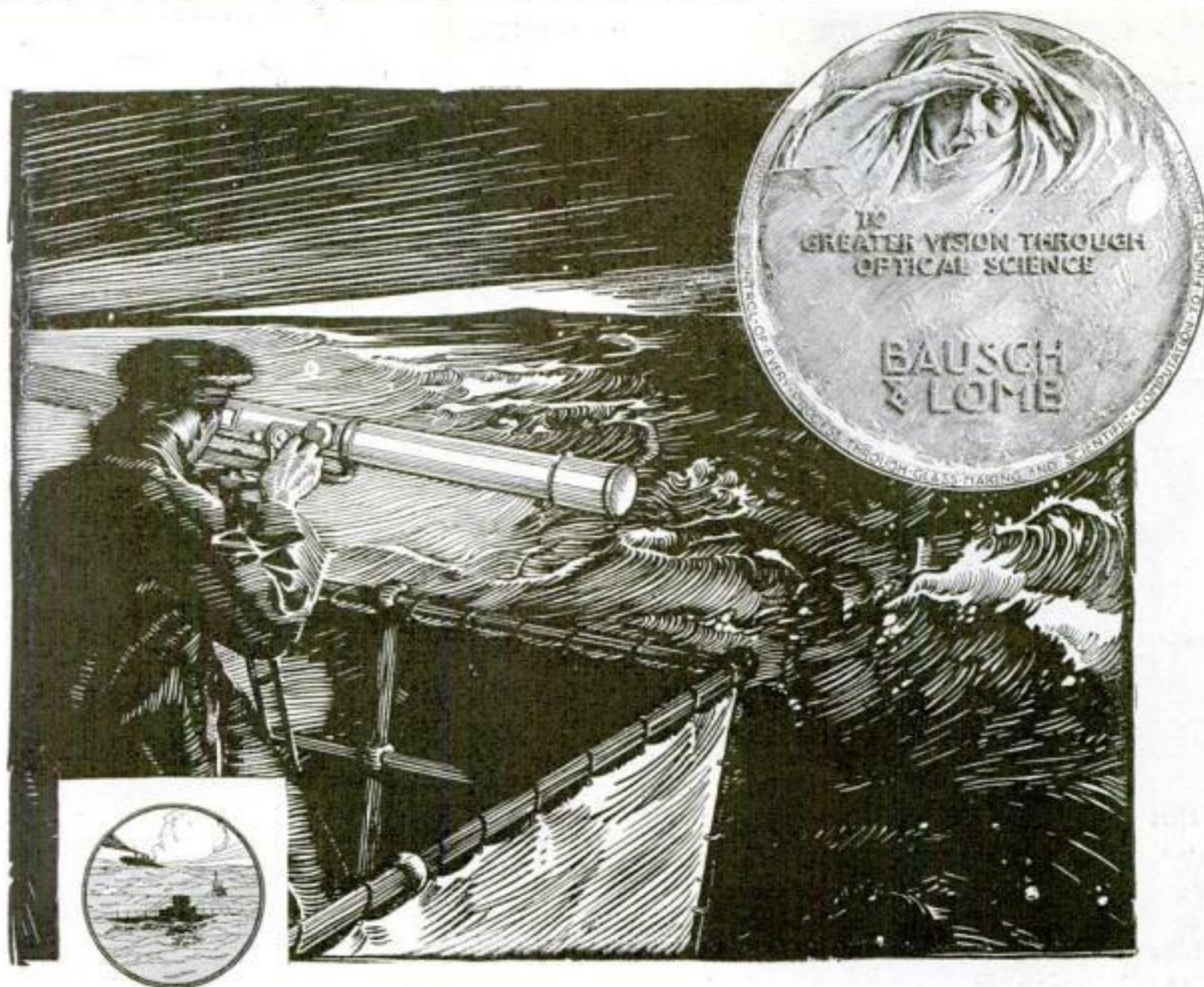
When the rope is attached to the differential housing, as in No. 3, the tendency is to spring the rear axle. When a connection is made, as in No.



At some time or other your car must be towed home. Here's the way to do it without injuring the car

4, the entire drag comes at one end of the rear axle, tending to pull the axle out of line. Of the two methods No. 4 is preferable if the tie shown in No. 2 cannot be made. Do not fasten the tow-rope to the frame of the car that is to do the towing.

When starting the car, move ahead slowly to take up the slack in the tow-rope without jerking. When under way, the driver of the towed car should keep the rope taut by using the brake if necessary.—RONALD L. PRINDLE.



Distant submarine, as seen through the range-finder.

When the Halves of the Conning-Tower Meet. Read the Range — and FIRE!

Do you know how our gunners find the range or distance of an enemy target—a submarine far off in gray wastes of sea, or an enemy post on a distant hill-side? They train a "range-finder" on it, turn a screw till the halves of the image meet, and read the distance in yards or meters directly from a scale.

It is a matter of seconds only. Through deflection of light rays by a movable prism, the instrument measures angles and computes the distance, mechanically, accurately, instantly.

But distances are so great, and angles so infinitesimally small, that the slightest flaw in the glass, the slightest error in computation or formula, the tiniest deviation in edge or side of the many-angled prisms, will destroy the instrument's usefulness—turn a hit into a miss, perhaps victory to defeat.

That we were able in a great emergency to supply our Government not with the usual few

score, as in former years, but literally with thousands of range-finders, and at no sacrifice of Bausch & Lomb scientific standards—

That even when working to a thousandth part of a millimeter we have been able to devise machines for large-scale production of range-finders, binoculars, gun-sights, aiming-circles, searchlight mirrors, periscopes—all the optical instruments of modern warfare—

This is both a source of pride to us, and a suggestion of our equipment for the improvement of optics generally.

Write for literature on any optical product in which you are interested

BAUSCH & LOMB OPTICAL COMPANY . . . ROCHESTER, N. Y.

Makers of Eyeglass and Spectacle Lenses, Photographic Lenses, Microscopes, Balopticons, Binoculars and Engineering and other Optical Instruments



An Apparatus for Slotting Instrument Bases

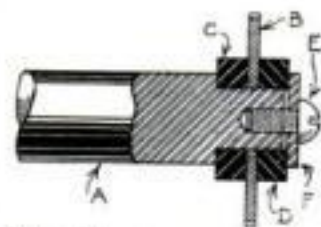
VERY often the amateur mechanic and model-maker has occasion to slot the bases of a number of instruments to allow wire connections to lie flush with the bottom. The apparatus described is used in a large shop where hundreds of bases, of all kinds of insulating material, such as hard rubber, wood, fiber, etc., are slotted with complicated arrangements of slots running in all directions on the base.

The device for doing the work consists of a length of shafting about $\frac{3}{4}$ in. in diameter and 18 in. long, with one end turned down to a $\frac{1}{2}$ -in. diameter, and back for about an inch. The saw used is a screw-slotting saw $1\frac{3}{4}$ in. in diameter with a $\frac{1}{2}$ -in. hole, costing but a few cents. The way the saw *B* is mounted on the spindle *A* is clearly shown by the cross-section illustration.

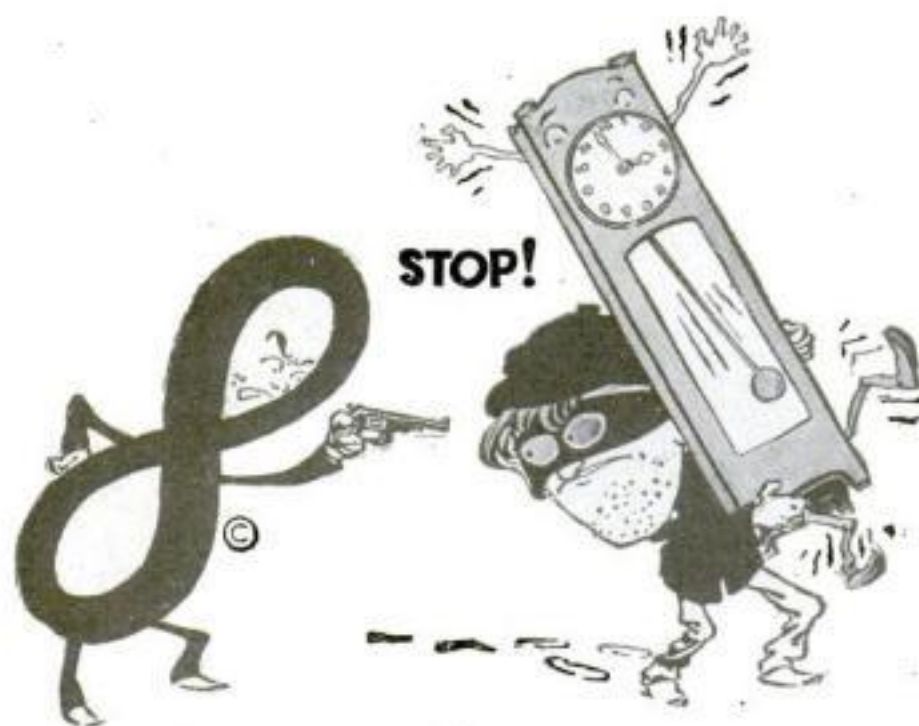
A thick ring or washer of fiber *C* is slipped on the turned-down portion of the spindle *A*, then the saw is slipped on, and is followed by another similar ring of fiber *D*. This last ring projects slightly beyond the end of the spindle to allow the machine screw *E*, which is screwed into a threaded hole tapped in the end of the spindle *A* and the metal washer *F*, to clamp the three securely together.

The diameter of the fiber ring regulates the depth of the slot to be cut, and a new set is required for each depth desired.

The spindle or shafting is held in the chuck of a speed lathe, with as much of it protruding beyond the chuck jaws as is necessary to allow the work to be done properly. The workman holds the base firmly in his hands, resting it against his chest to steady it. The saw is revolved with the teeth turning toward the operator and the work held against the bottom of the saw. If very sharp curves are to be made, a small saw must be used.—J. A. WEAVER.



This tiny saw cuts the slot to the depth needed



The Figure 8 saves time

FOR it's the magic figure 8 motion of the water in the tub of the 1900 Cataract Washer that sends that water through the clothes four times as often as in the ordinary washer! Thus it washes the clothes faster and better.

When you use a 1900 Washer there's no danger of buttons flying off and button holes tearing out—not one single part in the tub to cause wear and tear! The hot cleansing water is forced through the clothes by the action of the tub alone and not by any parts! This means, too, that you don't have any heavy cylinders to lift out and clean.

These facts combine to make the 1900 the perfect washing machine. In addition, the swinging wringer—which also works electrically—can be shifted from the washer clear over to the clothes basket without any moving of the washer; the 1900 works easily and smoothly; costs less than 2c an hour to operate; washes a tubful of clothes in 8 to 10 minutes.

The water swirls through the tub in a figure 8 movement four times as often as in the ordinary washer.



Comes in 8 and 12 sheet sizes.

Our Special Trial Offer

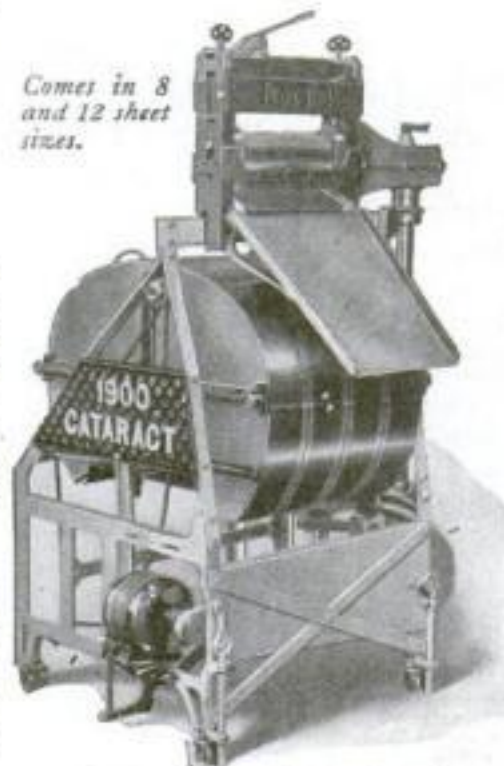
You may prove to yourself that the 1900 is the perfect washing machine. There is a 1900 dealer near you who will gladly demonstrate a 1900 Cataract Washer right in your own home. Then if you wish, you may start paying for it on terms to suit your convenience. Remember, we also have washing machines operated by hand and water power.

Write us today for the name of the nearest 1900 dealer, and a copy of the book "George Brinton's Wife." It's a story you will enjoy. Molly, his pretty little wife, had troubles of her own until she interrupted a bridge party, and then things began to happen.

1900 CATARACT WASHER

1900 WASHER CO., 206 Clinton St., Binghamton, N. Y.

Canadian Factory and Office
CANADIAN 1900 WASHER CO.,
357 Yonge St., Toronto



Just connect it with the electric light and off it starts.

1900 WASHER COMPANY
206 Clinton St., Binghamton, N. Y.

Please send me the name of the nearest 1900 dealer, and a copy of the story "George Brinton's Wife."

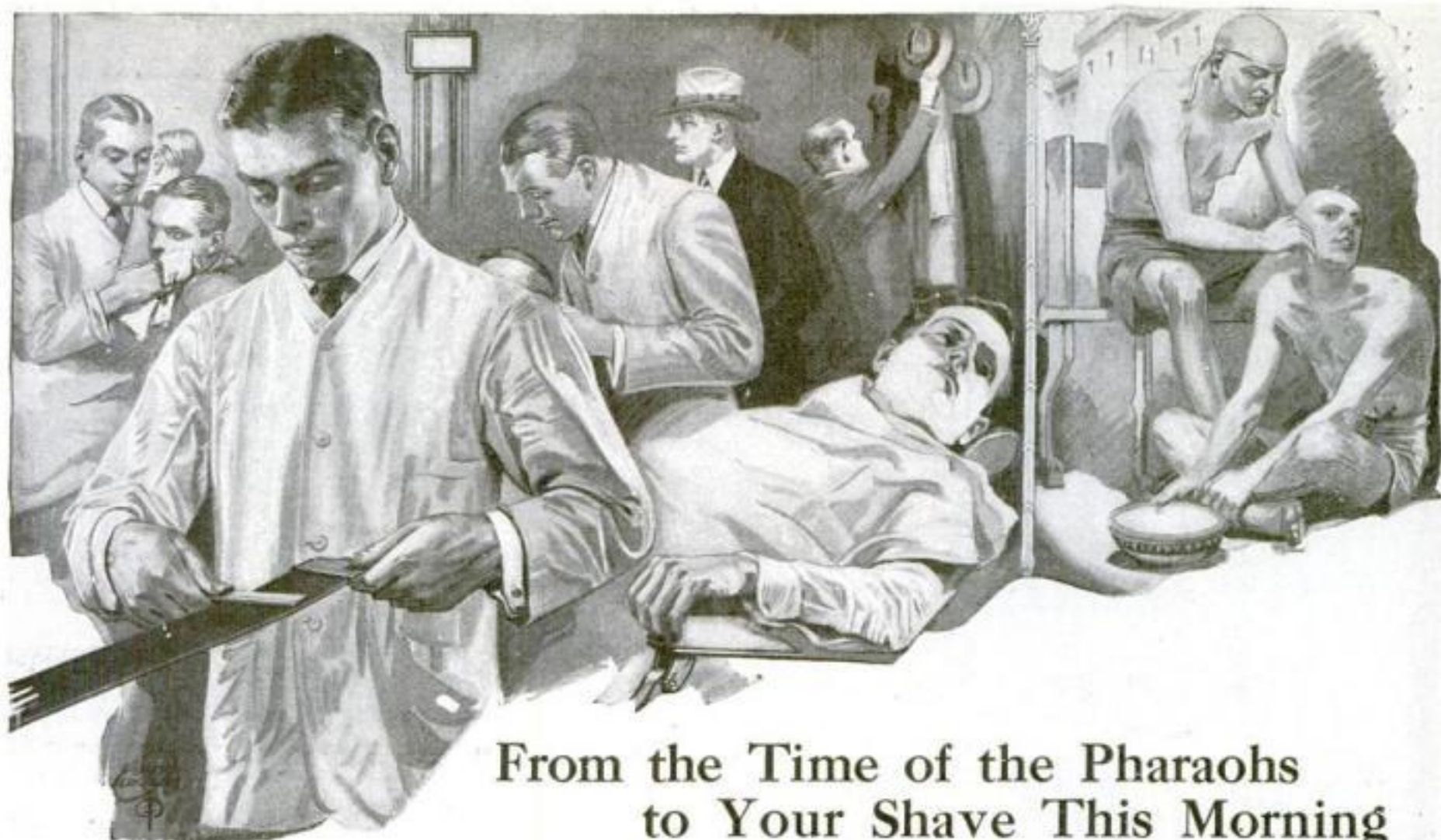


NAME _____
ADDRESS _____
CITY AND STATE _____

A Double Punch for Paper, Fiber, or Rubber Washers

IT is frequently necessary to make a number of washers out of paper, thin fiber, or rubber, as shown in Fig. 1. If two punches are used it will be practically impossible to get the inside and outside circumferences concentric, and if a solid punch is used it will be hard to sharpen and the cut washers will be difficult to remove.

Fig. 2 shows a double punch that may be used to cut washers either by pressing by hand or by striking the punch with a hammer. It consists of two parts—the outer (Fig. 3) forming a punch to cut the outside diameter



From the Time of the Pharaohs to Your Shave This Morning

IN the VIIIth Egyptian Room of the Metropolitan Museum of Art, New York City, there are two razors belonging to the time of the XVIIIth Dynasty (1580 B. C.)

The high-caste Egyptians of that period shaved not only the face, but the entire head. They wore wigs or other head-coverings. Those old Egyptian beards seen in ancient carvings were false beards. Sandals were owned only by the grandees, seldom worn, often carried by an accompanying slave.

The man being shaved squatted upon his haunches, the barber had the chair. And the razor then used, 3499 years ago, was the single-bladed, regular razor used by every barber without exception today.

Think of the many different sorts of razors that must have been invented, used for a time, and then dropped even from the long memory of History in the course of those 3499 years.

Those ancient razors were single-bladed like Genco Razors of today. Barbers still use only this one type of razor, because a better tool for shaving purposes has never been discovered. Also, because they know, and will tell you if asked, that any blade

must be stropped to deliver a perfect shave. You, too, can strop one regular razor for a perfect shave every morning.

Anybody Can Strop a GENCO Razor

Three features make stropping it almost as simple for you as breathing. Its broad back, its carefully concaved surface, and that important supporting bevel immediately behind the edge prepare each GENCO to lie against the strop just right. Your hand is guided. A few easy strokes—three or four each way, seldom over half a dozen—and there's that keen, smoothly cutting edge which every barber knows he has to have.

You save time. You save money. You begin the day with the sort of quick, cool shave that quickens your step and mind. The morale of a good shave—we don't need to go into that with you. You need only a regular razor for a real shave.

Your dealer will show you the three GENCO features. Each razor is hand-ground and delicately tempered. Look at the beautiful steel in it. We stand solidly behind it—"GENCO Razors must make good or we will."

If your dealer is out of GENCO Razors, write to us for one.

GENEVA CUTLERY CORPORATION, 47 Gates Avenue, Geneva, N. Y.

Largest Manufacturers of High-Grade Razors in the World

To Dealers: Inquiries and orders for GENCO regular razors arrive by every mail. We prefer to send you those coming from your town. Our handsome GENCO Display Cabinet free, with your first order, will make big Christmas sales for you. Write us today for additional information.



Note how GENCO Razors meet the strop in just the proper way to assure a perfect shaving edge. The bevel lends backbone to the edge and guides it on the strop.

GENCO

RAZORS

Reg. U. S. Pat. Off.

Dayton Bicycles



Choose Now

*We back this Trade-Mark
with our Reputation*

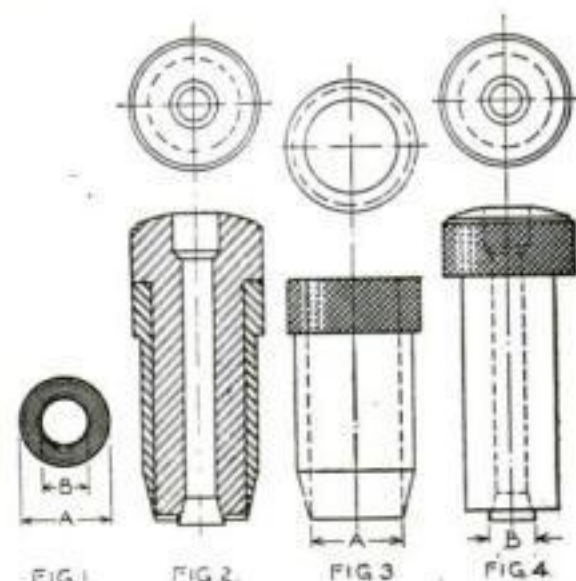
THE WONDERFUL DAYS of Spring are "just over the hill"—and right now is the time for you to be choosing and buying the Dayton Bicycle that will make your every day a happier, more profitable day. For nearly 25 years Dayton Bicycles have been leaders in design, workmanship, quality, service and rider satis-

faction. They are built with extra care and are best appreciated by those who demand superiority and painstaking attention to every little detail. Beautifully illustrated catalog pictures and describes 8 new 1920 Dayton Models—for boys, girls, men and women. Free. Write for Catalog 44 today.

Cycle Dept., THE DAVIS SEWING MACHINE CO., Dayton, Ohio

"Ride a Bicycle"

of the washer, and an inner one (Fig. 4) that punches out the hole. It will be noted that the outer punch is sloped off on the outside, while the inner one is tapered inside. The outer sleeve is drilled and reamed and the inner piece



Why buy a punch to cut out washers when you can easily make the one illustrated which serves a double purpose?

turned to make a good working fit without play. The inner punch extends slightly below the outer one, so as to get a firm hold on the material before the outer punch begins to cut. A hole through the center facilitates removal of the cuttings, and is counter-bored at the top to prevent the inner hole being peened over from hammering.

For cutting paper or rubber it will not be necessary to harden the punches, but it is necessary if it is desired to cut fiber.—H. H. PARKER.

A Filing Envelope that Gives Flexibility

AN envelope filing system is very compact, and for the simple requirements of the home is one of the best that has been suggested to the POPULAR SCIENCE MONTHLY. For clipped matter, a series of big manila envelopes, alphabetically indexed under subject classifications, is much superior to the scrapbook formerly so much in vogue. The objection to the ordinary scrapbook system is one that is not flexible. A good deal of the filed matter is sure to be pasted in, which later is not desired. There is no convenient way of removing it, and so the dead matter keeps accumulating.

Here is a homemade filing container comprising three parts. The first part is the big manila envelope, as strong and durable as can be obtained. This envelope is sealed and then slit at one end. On the front is pasted a second envelope of the common letter size, the flap of which has been cut off. This holds the small filing unit, a piece of writing paper cut to fit inside. On this slip is entered a list of the larger envelope's contents. The writer finds this a good working file. The secret of its success is the index slip.—JOHN T. BARLETT.

WINCHESTER

1866

1920



Winchester .22 Caliber
Repeating Rifle, Model 06

HOW I WON MY JUNIOR MARKSMAN MEDAL

WHEN my father bought me my new Winchester repeater, he said it was because I had joined the Winchester Junior Rifle Corps. But it really wasn't the fine medals that you can win in the W. J. R. C. that interested him. What he liked most of all was the rules.

The W. J. R. C. won't let you shoot for a medal unless you handle your rifle right and take proper care of it. Of course I wanted a medal, so I learned the Rules of Rifle Safety right away.

The distance you shoot in the W. J. R. C. is fifty feet. Five shots are fired at each target, when trying for a medal. If all five hit the bull's-eye, it counts 25. If they scatter, some shots count 4, 3, 2, or maybe nothing. It certainly is easy to scatter them!

Ten targets each counting 19 points or more, win a W. J. R. C. Marksman Medal and Diploma. It took me just three Saturdays to win mine, and I used only three boxes of cartridges.

Mr. Bradley, our instructor, says I have succeeded because I have followed the rules and done what he has told me to. But I also give a lot of credit to the fine accuracy of my Winchester repeater.

You don't really need a repeater. The rules just say you must use a .22 caliber Winchester. Lots of boys have the little single-shot kinds that cost very little. And Mr. Bradley says the steel in all Winchester barrels is the same quality and they are all bored the same way. He also says that many of the most expert small-bore marksmen in the world use exactly the same Winchester cartridges we do.

Next stop for me is Sharpshooter! The only W. J. R. C. Sharpshooter Medal in town that I know about, is on exhibition down at our leading hardware store. I don't think it is going to leave there very soon. But whoever else wants it, had better watch out for me and my Winchester repeater.

¶

Let's go, boys! Each of you, hike down to the hardware or sporting-goods store in your community where they sell Winchester .22 caliber Rifles and Ammunition. Buy a rifle if you need one, and some ammunition; register your name as a member of the W. J. R. C., and ask for some targets and an instruction book. Then try your hand at winning a medal. Right away. If you need more information, write at once to us.

To Separate Boiled Eggs from Raw Ones

SOMETIMES, in preparing for picnics or in saving left-overs, boiled eggs are accidentally mixed with raw ones. Here is a quick and sure method of separating them: Place the eggs on a smooth surface and give them a twirl with the thumb and first finger. A boiled egg will spin around on its side just as one would expect it to do; but a raw egg will refuse to spin, however hard it is twirled.

The Hairpin Becomes a Pair of Calipers

A PAIR of calipers is perhaps the most frequently used tool in the machine-shop, being required for almost every kind of job.

One day the writer wished to take some outside measurements and he

How can you be without the humble hairpin again? It's absolutely necessary



couldn't find his calipers in the toolbox. His eye lighted on a scrub-woman in the next room and a bright idea came into his head. Why not beg a hairpin and make a pair of calipers with it? He followed up his idea, the measurements were taken, and when the job was finished it was found to align properly.—A. G. VIDAL.

Cleaner-Cans Can Be Used as Nail-Containers

IT is often a problem for a carpenter to know how to carry nails, screws, etc., especially when he is using small brads, tacks, and hooks. Most carpenters use tea- and coffee-cans, but these have unpleasantly sharp edges.

One man solved the difficulty by using the discarded cans in which commercial bone-meal cleansers are commonly sold. These cans are made of heavy cardboard, and have a tin bottom.

By cutting a can in two, a box of any desired height from one to four inches is obtained. Such a box is light, strong, and of just the proper width for the fingers to enter. For larger nails, which occupy more space, it can be made higher. For small brads, screws, tacks, and the like, of which only small quantities are usually kept on hand, the box can be made shallow.

A great deal of petty annoyance is thus avoided.—HENRY SIMON.

Here is the ordinary braided cable covering. Note the open and porous construction, easily cut, stretched or unraveled. Compare it in detail with Duracord.

This is Duracord. Thick, heavy strands, woven like a piece of fire hose, not braided. Picture shows outside covering only with impregnating compound removed.

You judge its strength

THE outside covering of a portable cable gives it its mechanical strength. Underwriters demand that the electrical strength, the copper and the insulation meet their requirements—but you must decide whether the covering makes the cord as strong as it should be where the wear comes—on the outside. You must decide between braided covering and woven covering. Economy demands the decision.

DURACORD

TRADE-MARK

is protected by a covering of thick heavy strands woven like fire hose. It can be battered and pounded and abused, and stands up as no other cord will. The illustrations tell part of the story.

No wonder Duracord resisted the pounding of heavy test hammers twenty times longer than braided cord. No wonder it withstood abrasion tests fifteen times longer than cord with ordinary covering. Field tests are even more convincing of its unusual strength. Made in all sizes for every purpose.

Let us send samples of Duracord and ordinary cord. Show them to your purchasing agent. Get your engineer's opinion. Test and compare them yourself. We'll rely on your judgment.

Ask your electrical jobber about Duracord, or write us.

TUBULAR WOVEN FABRIC COMPANY
Pawtucket, R. I.

Makers of Duraduct Flexible Non-Metallic Conduit.



Enjoy It!

MAKE your trips to and from work a pleasure instead of a mean ride on a hot, crowded car. Ride a bicycle. Enjoy to the fullest the exhilarating tonic of fresh air and the open country.

My, how good you feel! The red blood sings thru your veins, driving away those mean morning headaches and that old sluggish feeling! You get to work feeling like taking that old job and fairly "eating it up!" Health and a clear brain go a long way towards making a successful man. A bicycle goes nearly all the way towards making a healthy man!

Then think of the convenience. Think of the money saved. Think of the pleasure of long rides in the country—of happy trips over broad roads! Is it any wonder that more people are riding bicycles today than ever before?

The bicycle is the most economical mode of transportation. It is the most healthful. It is a pleasant benefit for every member of your family.

Order your bicycle today. The more you ride it the more you'll enjoy it!

"Ride a bicycle"

The Cycle Trades
New York



of America, Inc.,
U.S.A.

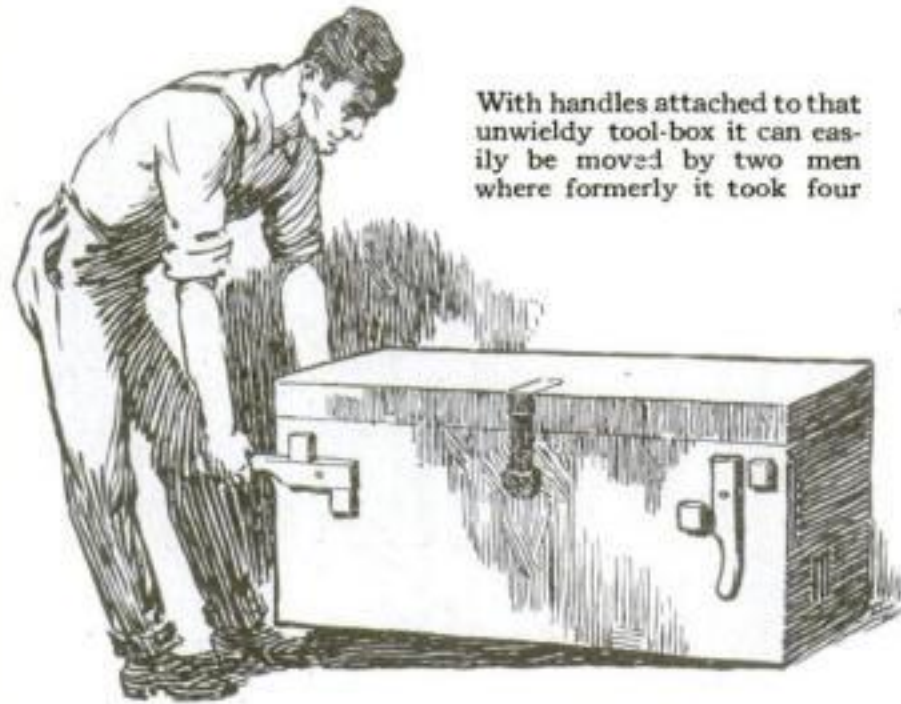
Folding Handles Facilitate Heavy Lifting

By Thomas W. Benson

WHERE a number of mechanics are working together on a job, the usual practice is to keep all tools

The dimensions can be varied to suit requirements. For the average box the handles are cut from strips 18 in.

long, 4 in. wide, and 1 in. thick. The hole for the pivot bolt is 6 in. from one end. The stops are cut from the same material and nailed or bolted in position. Washers should be used under the heads of the pivot bolts to insure easy action. The illustration also shows the handles in both positions. When filled with tools, the box, naturally, is very heavy. Without the handles it is hard work for four men to



With handles attached to that unwieldy tool-box it can easily be moved by two men where formerly it took four

locked in a large box overnight. The illustration shows a simple method for equipping such boxes with folding handles that drop down out of the way when not in use.

carry it from place to place. This necessitates calling them from other work to lift the box. Try this suggestion on your tool-box—it is a time-saver.

Adapting a Gasoline Engine to Burn Kerosene

By L. B. Robbins

THE mixer on almost every gasoline engine has an exposed air-intake valve. These valves are occasionally fitted with a gate for adjusting the amount of air admitted, but as a rule they are left at a fixed opening and the mixture adjusted at the gasoline supply.

In such cases it is a simple matter to readjust the proportions of air and fuel so as to run the engine equally well on kerosene as on gasoline. This can be done to the usual style of mixer by inserting a rightly proportioned bushing in the mouth of the air intake itself. If the mouth of the intake projects downward tap into it an elbow, so that the mouth will be either horizontal or upright.

Kerosene is much less volatile than gasoline, and the object is, of course, to gasify it as quickly as possible. This calls for a little experimenting.

First, with a bushing in the air intake, pour in a little gasoline, and, closing the ignition switch, turn over the flywheel and start the engine. When it picks up on the gasoline turn the needle valve of the mixer so as to admit about half the amount of kerosene that it formerly admitted of gasoline. If the engine slows down pour in a little more gasoline until the cylinder becomes well heated. After a few moments of running the kerosene can be gradually cut down until the engine is operating on about a third

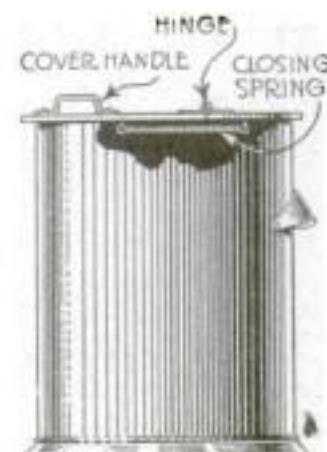
the amount of fuel that was formerly used. When the proper points on the needle valve indicator are once located, mark them and you will always be able to operate the engine satisfactorily.

It is suggested that this arrangement be made on a marine or stationary engine of from one to four cylinders. It will not work to advantage upon an automobile engine, because the use of kerosene causes the cylinders to carbonize quickly.

A Soiled Waste Receptacle for Machine-Shops

IN factories and work-shops where a lot of oily waste accumulates, some sort of safety waste receptacle

should be provided. A waste can such as the one illustrated will prevent the danger of fire through carelessness and the resultant loss. The main feature is the closing spring which makes it impossible for the cover to remain open unless held in place.



By using a metal container for oil waste you avoid fire danger



Give your door a Yale Door Closer—and it will close as "Soft as cotton"

A DOOR not equipped with a Yale Door Closer is unwieldy, destructive, bothersome. It either crashes shut with a nerve-racking, plaster-shaking, splintering slam, or stays open, allowing chilly dust-and-germ laden drafts to sweep in.

A Yale Door Closer completes the door—closes it every time it is opened, silently, easily. It saves nerves, conserves heat and preserves the door itself.

Your hardware dealer will sell you the Yale Reversible Door Closer for main entrance, closet, library, kitchen, bath and screen doors. You can install them yourself, without knowledge of their internal mechanism.

See the trade-mark "Yale" on Yale Door Closers, the same trade-mark that guarantees Yale Cylinder Night Latches, Padlocks, Builder's Locks and Hardware, Chain Blocks and Electric Hoists.

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Makers of the Yale Locks

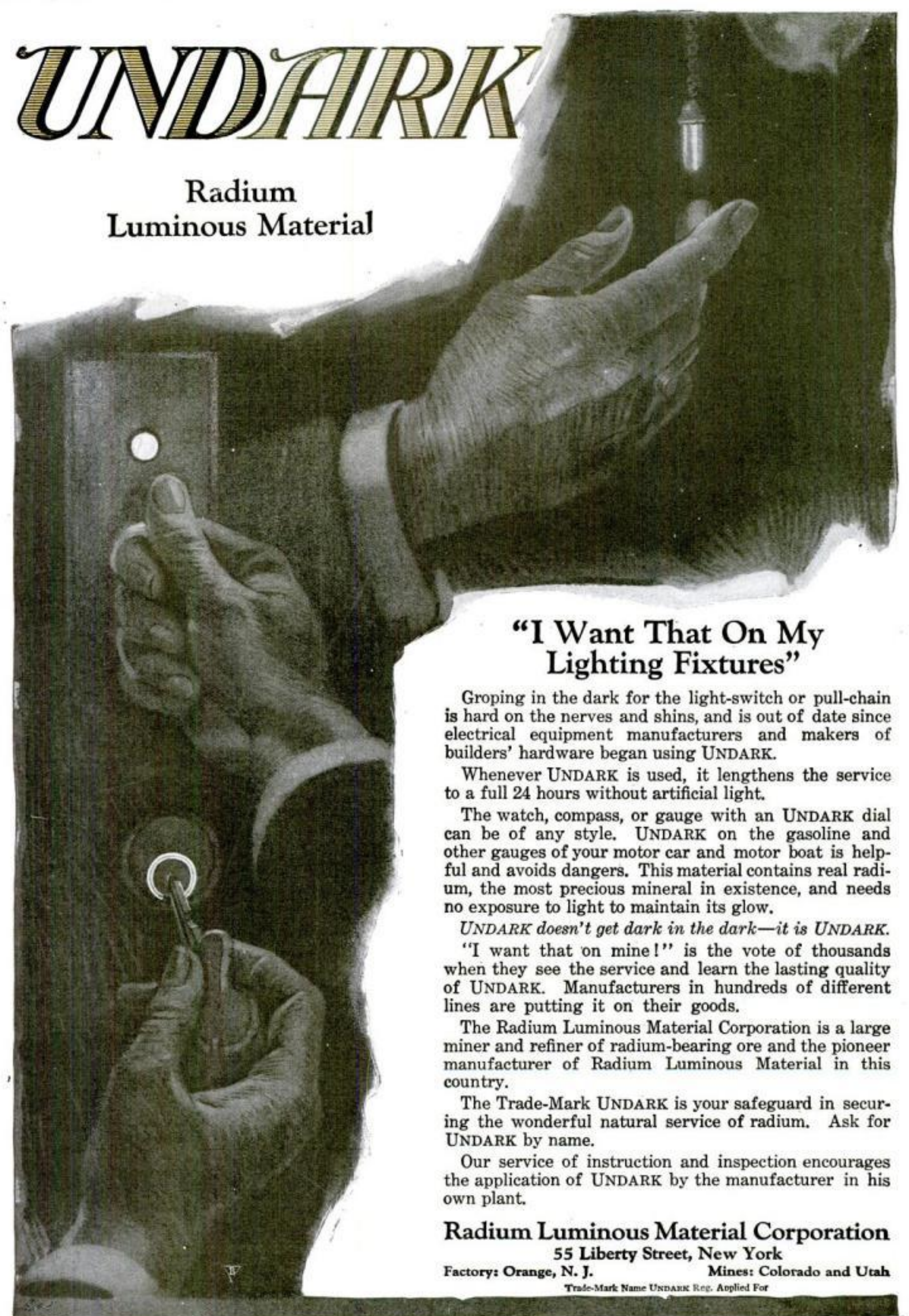
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UNDARK

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Luminous Material



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Groping in the dark for the light-switch or pull-chain is hard on the nerves and shins, and is out of date since electrical equipment manufacturers and makers of builders' hardware began using UNDARK.

Whenever UNDARK is used, it lengthens the service to a full 24 hours without artificial light.

The watch, compass, or gauge with an UNDARK dial can be of any style. UNDARK on the gasoline and other gauges of your motor car and motor boat is helpful and avoids dangers. This material contains real radium, the most precious mineral in existence, and needs no exposure to light to maintain its glow.

UNDARK doesn't get dark in the dark—it is UNDARK.

"I want that on mine!" is the vote of thousands when they see the service and learn the lasting quality of UNDARK. Manufacturers in hundreds of different lines are putting it on their goods.

The Radium Luminous Material Corporation is a large miner and refiner of radium-bearing ore and the pioneer manufacturer of Radium Luminous Material in this country.

The Trade-Mark UNDARK is your safeguard in securing the wonderful natural service of radium. Ask for UNDARK by name.

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458 Cities in 48 States
have increased Street car
fares—more than 35,000,000 people
affected

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the nation's lowest
cost, most dependable
means of transportation—



Columbia
BICYCLE

You *can* estimate the saving in dollars and cents that would be effected by riding a Columbia Bicycle.

This saving would soon pay for a new Columbia and you could then keep right on saving.

You *cannot* estimate the great *physical* and *mental* benefits a full season's use of the Columbia would produce—freedom from crowd-packed cars, from uncertain running schedules, from lost time, from those many discomforts and work interruptions caused by unsettled, inadequate, and expensive trolley facilities.

The Columbia is the American family's time, money, and health saver. It makes getting to and from work a healthful, pleasurable pastime. Light but sturdiest in construction, dependable always, comfortable, up-to-the-minute in style lines, finish, and equipment.

Step into your local dealer's and inspect the new Columbias—he will be glad to explain their many features.

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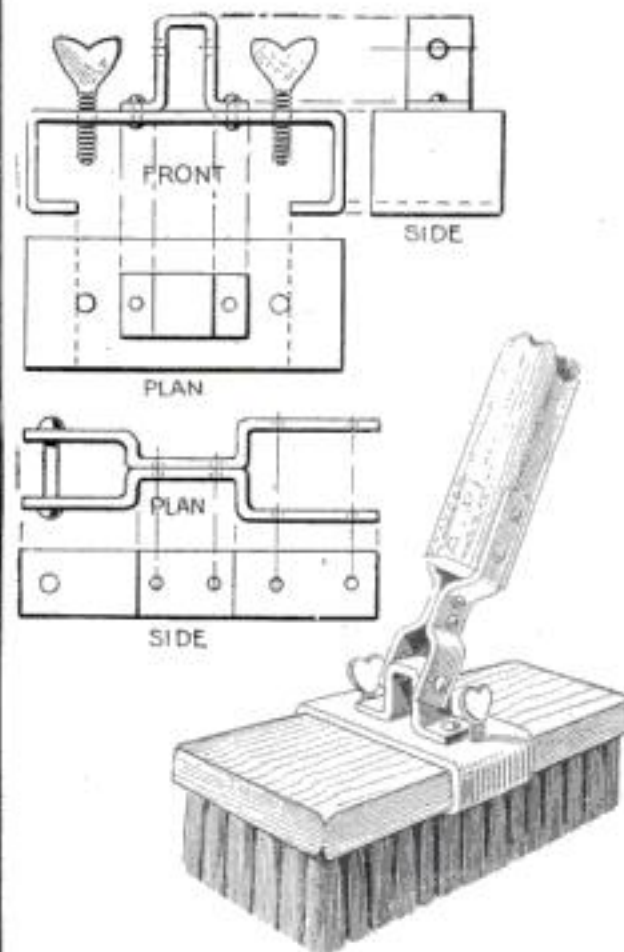


RIDE A
BICYCLE



Stand Up When You Scrub the Floors

A VERY useful article and labor-saving device can be easily constructed from strap-iron. It will fit any scrubbing-brush of standard size and is designed with the idea of pre-



Scrubbing-brushes must be used at least once a week: why not make them as easy as possible to handle?

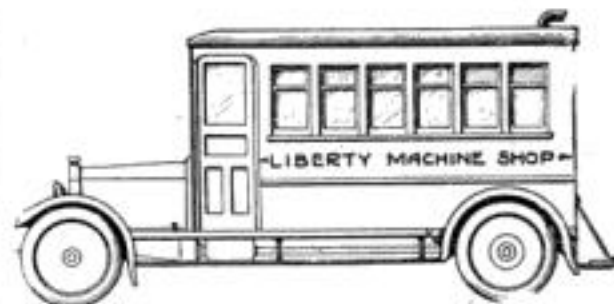
venting you from assuming the old-time knee position, which is so tiring.

The top of a broom is used for the handle, and the device itself is explained in the detailed diagram herewith. Two wing-bolts make the device adjustable. Any thickness of brush can be used from $\frac{1}{4}$ to $\frac{3}{4}$ in. and any width from 2 to 3 in.

An Old Automobile Made into a Portable Machine-Shop

WISHING to better himself, an enterprising street knife-grinder gathered together enough money to purchase an old discarded jitney bus, and turned it into a self-propelled and self-operating machine-shop on wheels.

All the seats except the driver's were removed, a hole was cut in the



Instead of the customer coming to the shop the shop goes to the customer

floor for the belt, and a split pulley attached to the drive-shaft in line with the hole. The size of the pulley was adapted to the speed of the line shaft.

A Remedy for Present Day Gasoline

NEARLY everyone knows that gasoline has gone down and down in grade. The fine gas of five years ago may still be purchased, but at drug store prices.

The common run of gas today has played havoc with many engines.

It has made them difficult to start on a cold day; causes frequent back firing; scored cylinders, burned bearings, abnormal carbon deposit, and amazingly frequent grinding of valves.

Many engineers saw this condition coming years ago, but the Chalmers engineers were the first to develop a remedy.

They knew there was as much power in a low grade gas as in a high grade gas.

To get out all the power that nature put in was the task.

They designed two devices—Hot Spot and Ram's-horn.

Hot Spot "cracked up" the gas to a very fine vapor after the gas left the carburetor,

and then turned over the fine vapor to Ram's-horn, which dispatched it a short and equal distance to each cylinder.

The effect on gas upon striking Hot Spot is like a drop of water striking the top of a hot stove.

Imagine the "cloud" of gas then rushed through Ram's-horn, which is minus sharp corners, abrupt bends and pockets; the distance to cylinders 1 and 6 being exactly the same as to the middle cylinders.

The result is instantaneous firing; instantaneous power; no "coughing" or back-firing. Instead quick acceleration, smooth action and vibration reduced to a negligible quantity.

Your first impression in a present day Chalmers is instantaneous starting on a cold day.

Your second impression is quick power results—you do not have to run two blocks to get your engine "warmed up."

Your third impression is a total absence of vibration.

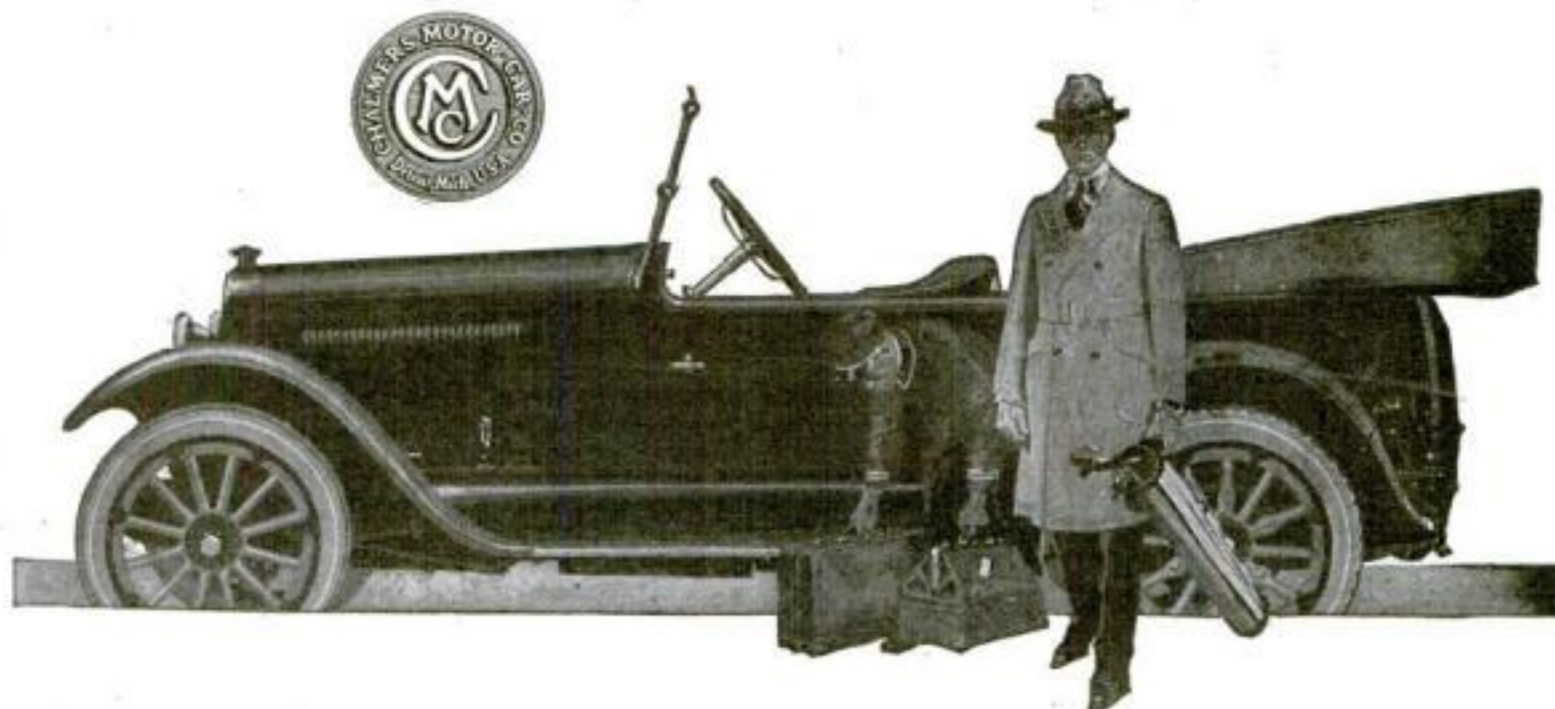
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DETROIT, MICH.

CHALMERS MOTOR CO. OF CANADA, LTD., WINDSOR, ONTARIO
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WITH HOT SPOT AND RAM'S-HORN



IVER JOHNSON SAFETY REVOLVER



The Sign of Positive Safety

Iver Johnson means Safety,
and Safety means Iver Johnson
—the two are inseparable.

Drop it, kick it, knock it, thump it, "Hammer the Hammer"—it can't go off accidentally. And its safety is automatic—nothing to remember to do to make it safe. That's why women are not timid about having an Iver Johnson in the home.

Choice of three grips

Regular, Perfect Rubber, Western
Walnut.

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Piston Ring
Patented Trade Mark Reg.
NO-LEAK-O Piston Ring Co., Baltimore, Md.

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On market 5 years.
1,000,000 a month.
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Perfect new tires, all sizes,
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Quick Sales—Nice Profit

Everybody buys. Housewife, mechanic, electrician, jeweler, plumber, tourist, automobilist, etc. No leak too bad to repair. Just apply a little "Soderese," light a match and that's all. Put up in handy metal tubes. Carry quantity right with you. Write for sample and special proposition to agents.
AMERICAN PRODUCTS CO., 2046 American Bldg., Cincinnati, Ohio

Along one side a bench was built up the proper height and shelves placed beneath it. The opposite side was fitted with a tier of drawers, while at the rear end of the bench was placed the forge, which is one of the hand-power kind. A small bench lathe, as well as a grinder, was placed on top of the bench at the front end, and a vise at the rear.

A smoke-draft hood was hung over the forge, and its smokestack run through the roof. The line shaft for running the lathe was hung in hangers to the roof. The driving pulley for this shaft has a clutch, so that when the machine-shop is on the move the machinery of the shop can be stopped.

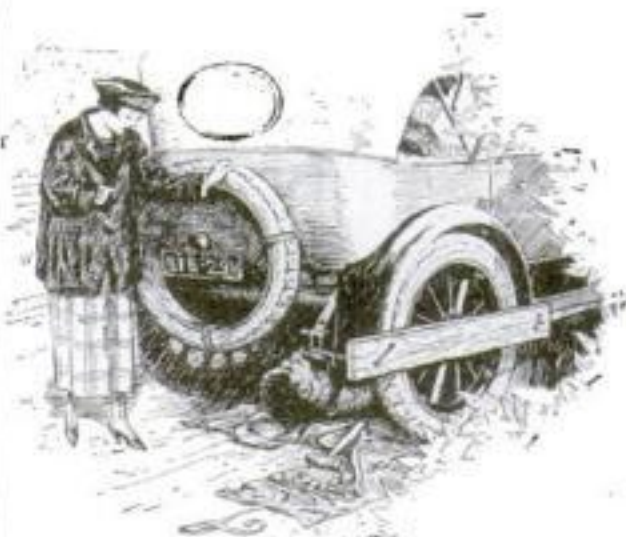
It was found that the original dome lights were not strong enough for the work, and two large barn lanterns were placed over the bench. These burned kerosene, and consequently it was not necessary to charge the storage battery to run the lights.

An acetylene welding tank and torch is carried in a rack made for the purpose, and the grinder has a very efficient money-making shop on wheels driven by its own power plant.—P. P. AVERY.

A Quick Road Repair on a Broken Automobile Axle

If your automobile's rear axle, either right or left, breaks, a quick "get home" job can be made with a taper punch and a piece of board.

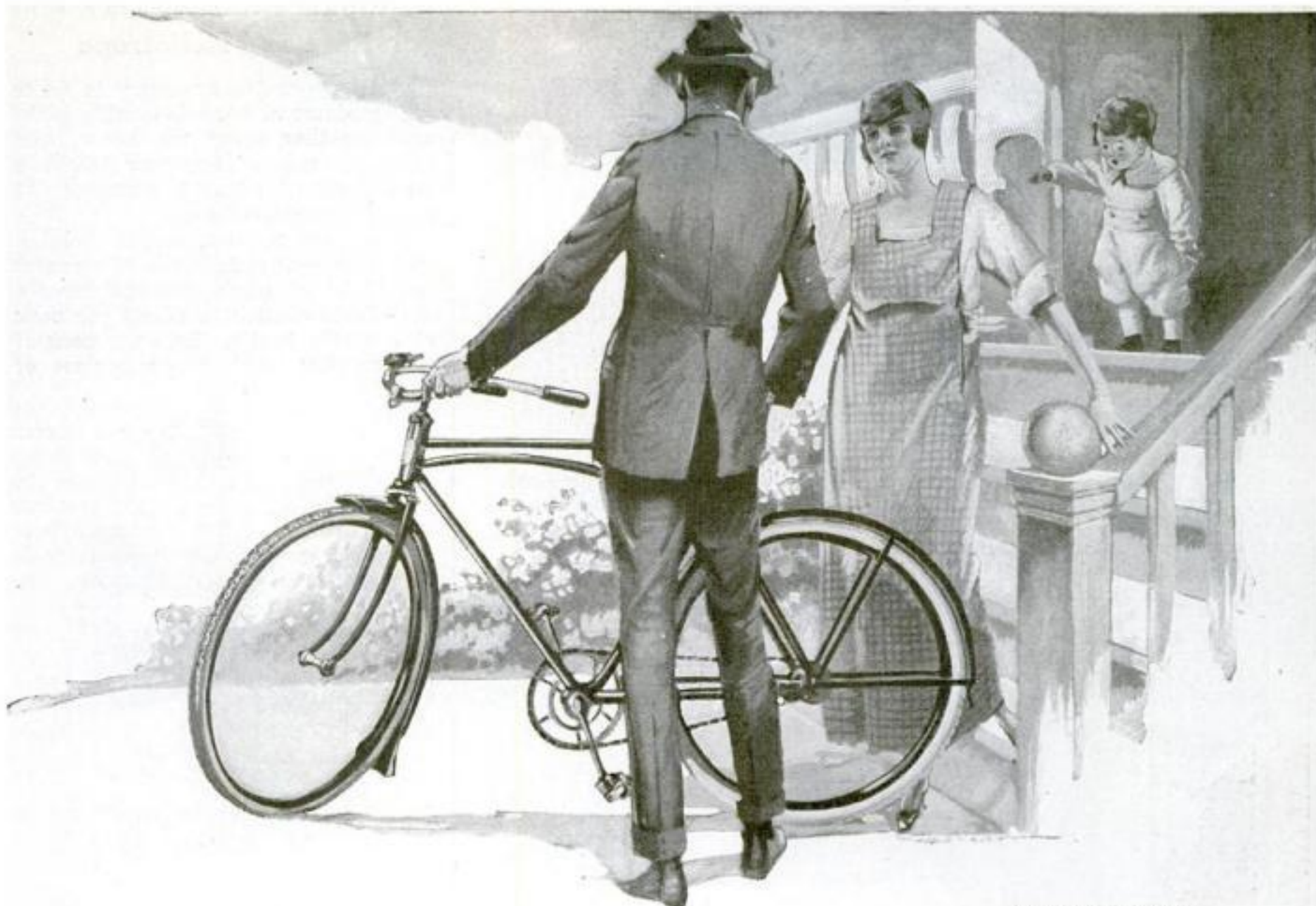
Remove the differential case-cover, insert the punch in the hole to keep it



No need to wait for the repair car if you adopt the above suggestion for repairing your broken automobile axle

from turning, and wire the board fast to the running-board and the rear end of the spring or mud-guard, as shown in the illustration. The board holds the axle in, and the punch keeps the axle and its gear from making the differential action, thus allowing the car to be driven home under its other axle.

Nine out of ten breakdowns occur in out-of-the-way places, and usually the driver is without the proper tools or parts to repair the break. By observing other motorists' methods of emergency repairs you will not be at a loss for a solution when your breakdown arrives.—P. P. AVERY.



"I'll be on time"

If the alarm clock fails, you can still keep your appointment with the time clock, if you own a bicycle.

There is no waiting for cars. Jump astride and be off with speed to spare.

And remember that the most efficient bicycle is equipped with the most dependable tires—United States Tires. Made by the world's largest rubber manufacturers to live up to an established reputation for long and trustworthy service.

United States Cycle Tires are Good Tires

CHAIN TREAD

The Chain Tread Tire goes straight ahead—no side-slipping or veering from the straight path—a skid with a Chain Tread Tire is an unknown quantity. And then see the bulk of good rubber in that Chain Design and then figure out the advantage you are going to gain from it in wearing qualities as well as the insurance it is to your safety. You'll make the best selection in the world when you put UNITED STATES CHAIN TREADS on your Bicycle.

Be sure it is United States



Manufacture Your Own Old Rose and Heliotrope

THE apparatus necessary to make perfume at home is quickly gathered together about the house, and perfume made in this way carries a far sweeter odor than the majority of manufactured perfumes.

First, secure two empty bottles. One of these is to hold the flowers and should be of ample size and have a neck large enough to admit the neck of a smaller bottle. Into the neck of this smaller bottle place a piece of



Those of you who have flower-gardens can make your own perfume. It is much sweeter than the store kind

very fine sponge, washed clean, then saturated with pure olive oil, and squeezed dry.

Fill the larger bottle with flowers; any kind will do as long as they have a sweet odor and are fresh. Fit the bottles together and place them in the sun. Next day throw out the old flowers, squeeze out the extract in another small, tightly corked bottle, and place new flowers in the bottle. Keep this up until the small bottle is filled with perfume, squeezing out the few drops each day. It is necessary to oil the sponge only once.

For each drop thus secured add one ounce of pure alcohol.—G. F. COLLINS.

Why Trade in Your Old Automobile?

THE engine of a good car will continue to function well years after the top and the finish on the body have become shabby. In fact, many cars are "traded in" just when the engine is at its best. All mechanics know a new piece of machinery doesn't operate smoothly until it has been run some time. Meanwhile the paint, varnish, lacquers, etc., put on to make it look attractive have lost their newness.

It is waste to discard a perfectly good engine just because the outer shell doesn't look as spick and span as it might. That defect is easily remedied.



*"It's
a
WDC"*

The most a man can expect in a pipe—and just a little more. The WDC is a pipe you have a right to be proud of. Genuine French Briar, Demuth seasoned, and guaranteed against cracking or burning through.

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WORLD'S LARGEST MAKERS
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The History of a Word

THE trade-mark "KODAK" was first applied, in 1888, to a camera manufactured by us and intended for amateur use. It had no "derivation." It was simply invented—made up from letters of the alphabet to meet our trade-mark requirements.

It was short and euphonious and likely to stick in the public mind, and therefore seemed to us to be admirably adapted to use in exploiting our new product.

It was, of course, immediately registered, and so is ours, both by such registration and by common law. Its first application was to the Kodak Camera. Since then we have applied it to other goods of our manufacture, as, for instance, Kodak Tripods, Kodak Portrait Attachments, Kodak Film, Kodak Film Tanks and Kodak Amateur Printers.

The name "Kodak" does not mean that these goods must be used in connection with a Kodak camera for as a matter of fact any of them may be used with other

apparatus or goods. It simply means that they originated with, and are manufactured by, the Eastman Kodak Company.

"Kodak" being our registered and common law trade-mark can not be rightly applied except to goods of our manufacture.

If you ask at the store for a Kodak Camera, or Kodak Film, or other Kodak goods and are handed something not of our manufacture, you are not getting what you specified, which is obviously unfair both to you and to us.

If it isn't an Eastman, it isn't a Kodak

EASTMAN KODAK COMPANY,
ROCHESTER, NEW YORK.

Grandma Knows Musterole Is Best

Remember the time when you had that dreadful congestion of the lungs—and Grandma slapped a stinging, messy mustard plaster on your chest? How you writhed and tossed and begged Grandma to "take it off"?

That was many years ago. Now, Grandma gets the jar of Musterole, for now she knows Musterole is *better* than a mustard plaster.

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Musterole is a clean white ointment made of oil of mustard and other home simples.

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Things I Made that Reduced the High Cost of Living

The Popular Science Monthly will pay fifty dollars for the best answer

WHAT new use of a mechanical appliance or machine did you make for the purpose of reducing the high cost of living? We know of one fellow that transformed his coal furnace into an oil burner. Another made an ice-less refrigerator. There are, of course, many other things and we want to know in how many practical ways we can reduce living expenses. Tell us! THE POPULAR SCIENCE MONTHLY offers three prizes,—a first prize of \$50, a second prize of \$25, and a third prize of \$15,—to be awarded in accordance with the rules set forth below:

Rules Governing the Contest

(1) Contestants are not limited to the number of methods of reducing the high cost of living, but only one method can possibly win the first prize, only one the second, and only one the third. The contest is open to everybody.

(2) The method must be clearly shown either in a photograph or in a drawing. If a drawing is sent in, it need not be made by a skilled draftsman. It is sufficient that it should be intelligible. While pencil sketches will be considered, contestants are requested to make their drawings in ink on heavy white paper. The views should be sufficient in number to set forth the use of the appliance very clearly. The contestant's name and address should appear on each sheet of drawings.

(3) The drawings or photographs must be accompanied by a description, preferably typewritten, in which the method is clearly given. It must be written on one side of the paper only, and it should not be more than 500 words in length. The name and address of the contestant should appear in the upper left-hand corner of the first sheet of the written description.

(4) The drawings and description entered by contestants must be received by the POPULAR SCIENCE MONTHLY not later than 5 p. m. on Friday, April 30, 1920.

(5) The judges of the contest will be the editors of the POPULAR SCIENCE MONTHLY.

(6) The first prize of \$50 will be awarded to the contestant who, in the opinion of the judges, has suggested the simplest and best method of reducing the high cost of living.

The second prize of \$25 will be paid to the contestant who submits a method next in merit.

The third prize of \$15 will be paid to the contestant who submits the method third in merit.

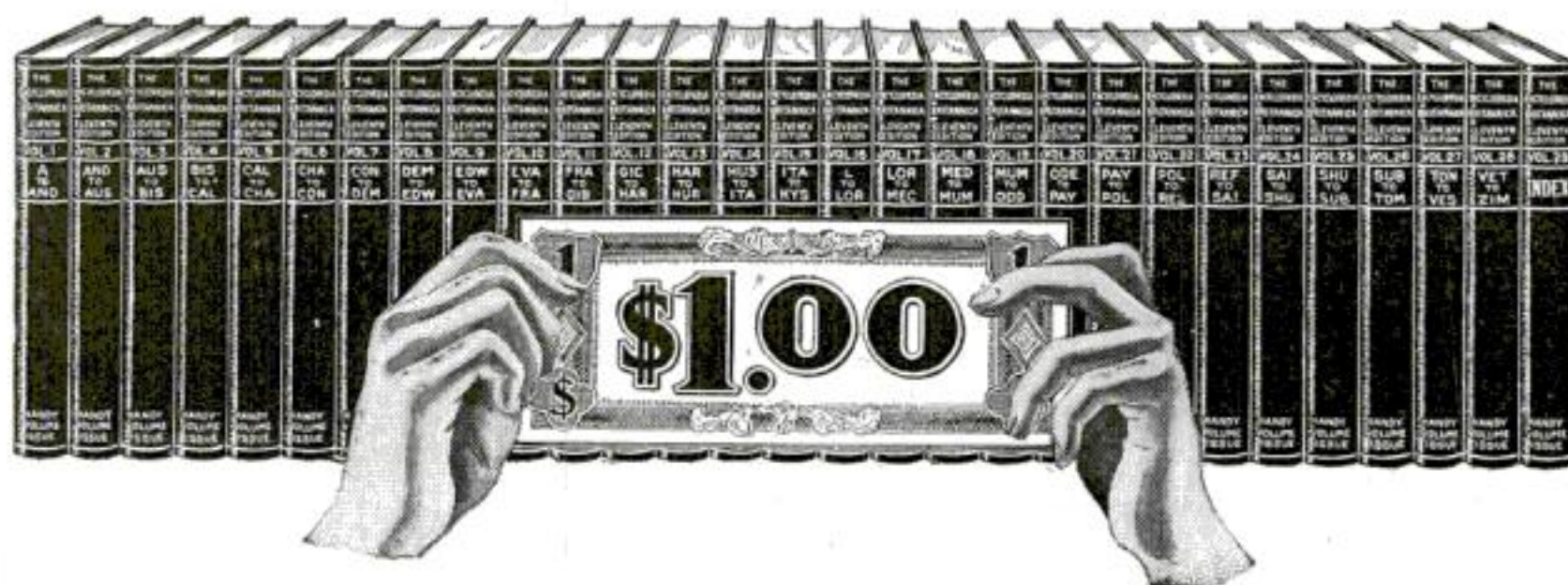
(7) The winners of the contest will be announced in the earliest possible issue of the POPULAR SCIENCE MONTHLY. A description of the methods which win the three prizes offered will duly appear in the pages of the POPULAR SCIENCE MONTHLY, together with the names of the winners.

(8) The editors of the POPULAR SCIENCE MONTHLY shall have the right to publish meritorious manuscripts which do not win a prize. The regular space rates will be paid to the contestants who submit the manuscripts thus selected.

(9) When a contestant submits more than one method, the description and drawing by which each is set forth must be sent as a separate unit.

(10) Manuscripts or drawings will be returned to contestants if stamps are enclosed.

(11) Send drawings and specifications to the High Cost of Living Editor, POPULAR SCIENCE MONTHLY, 225 West 39th Street, New York City.



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A Homemade Cold-Box for the Pantry Window

NOT all food preservatives are designed for the protection of eatables from warm temperatures. The accompanying illustration describes a food-container used exclusively in cold weather; hence the name cold-box.

The container is homemade, and can be attached to the outside of the kitchen or pantry window. A



The side view and front of the box show how easily it can be constructed. It will save you a big ice bill, too

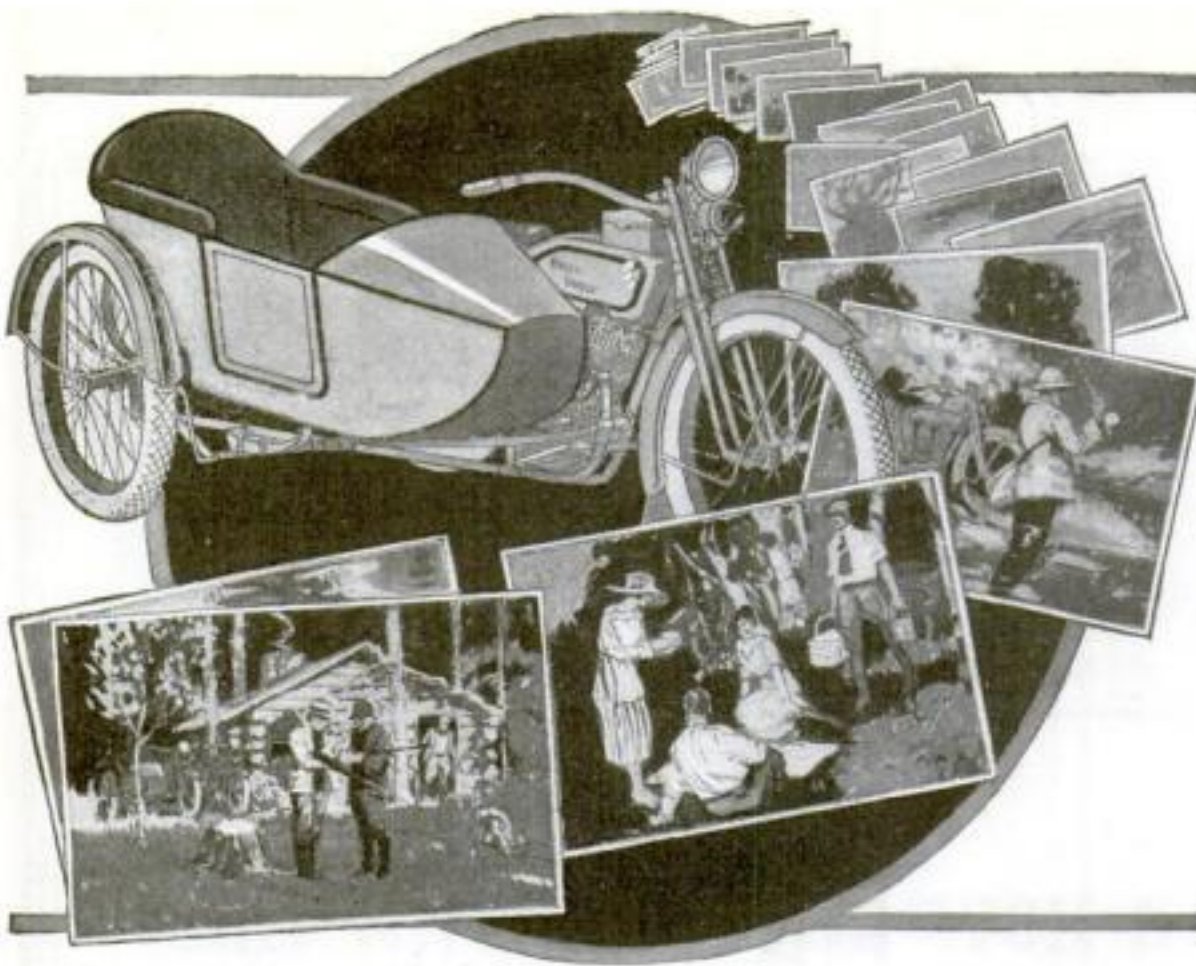
northern exposure is desirable; raising the window gives access to the cold-box, without shutting off the light from the upper half of the window.

The window-sill is extended by a shelf, supported by wooden brackets. The device rests on the window-sill and the extended shelf, being fastened to the window-cases by screws or nails near the top and bottom of each end of the box. The box should have a sloping top to ward off rain. Holes for ventilation are made in the end of the box, and screened. Shelves may be made of heavy screen, poultry netting, or wood. The shelves rest on cleats fastened to the sides of the box.

Food placed in the box should be covered, as a safeguard from dust. In warm weather the cold-box can be removed if desirable.—S. R. WINTERS.

Hints for Those Who Want Tire Mileage

IN the United States today there are more than one hundred legitimate tire manufacturers, and about fifteen of this number supply practically all motorists. The smaller tire manufacturers, the "seconds" shops, the "cut-rate" and the "retread" shops, take care of what business the big manufacturers do not handle. This business is growing by bounds, and each day new motorists and even thousands of old-timers are buying cheap tires. This is like getting a quack doctor when one is seriously ill. Tire value shows itself in the cost per mile, not in the cost per tire. As in



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everything else, the best tire is the cheapest in the long run, and the motorist who buys cheap tires finds that the cost per mile is much higher than is that for a standard high-grade tire.

In every large city there are shops displaying the sign "Standard Makes, 50 per Cent Off," and naturally the unwise are led to believe that they will get a regular first-grade tire at 50 or 30 per cent less than the standard tire branches can sell them for. In some of these shops you find that the tire has a name strange to you. It might be Clingstone or Soft-tread or some other name you never heard of; but the salesman tells you that it is a standard make and that this particular company is launching a new tire that is branded differently on account of its tread.

This is not the case. Standard makers take pride in stamping their trademark on their tires. A certain class of tire manufacturers do a regular business with these concerns, manufacturing tires under any name the dealer wants. Other factories market tires through various trade channels, selling as many as ten different brands of tires. These may be all from the same stock and design, though differing greatly in price. The



Did that second-hand tire you bought recently go bad? Read the article and learn just why it wasn't any good

tire list in this case is a joke, because the tires never sold at list prices at all. If a tire is listed at \$50 it is offered to you at 50 per cent off or \$25; and this is perhaps more than the tire is worth.

Every manufacturer has a certain number of "seconds" which he must dispose of in the best way possible. The so-called "rejects" are bought up by dealers, who purchase in large lots. Included in these "seconds" are old tires that have been in stock for a long time.

When you buy a "second" tire you are taking a big chance. It may last ten miles or it may run eight thousand. If the tire happens to blow out in a short time, you lose; if it doesn't, you are lucky.

Then perhaps you buy a second-hand casing. You can't tell by look-



Walled up Alive!

A startling truth develops when the new home is all built and folks start living in it.

All the bigger problems of plan and architecture grow daily less vital. The small conveniences, insignificant when planned, become the very means to family comfort.

Indeed, the incidentals in building actually become the requisites to living—and this is never more true than electrically.

That head of stairs switch to insure your footsteps against darkness means more in your daily life than the design of the roof, whether mansard or pitched.

The reading light alongside your bed offers more real human satisfaction than the style of your windows, be they dormer or bay.

And whether you planned the library for the first or second floor doesn't hold half the importance of an arrangement of lights kindest to your eyes.

There's a Niagara of energy running through the walls of your house. But how to tap it? Walled up alive in lath and plaster, this powerful servant is restive, eager to shine and cook and sew for you.

Arrange the necessary outlets and it will emerge to take up the work. Base-board outlets, placed plentifully in every room and hall. In the laundry for washing machine and iron. In dining room for toaster and grill, in bedroom and living room for vacuum cleaner.

Comforts you value but don't always provide. Trouble is, you don't call your electrical contractor in until the building is well along. Then first estimates of cost begin to prove inadequate and common sense seems to say save, do without, cut.

Don't do it.

Remember that you are building a home to live in. That additional electrical equipment costs relatively little, and that a few extra fittings will yield endless convenience and satisfaction.

Talk it over with your architect and your electrical contractor.

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ing at it, or even by examining it closely, just how far it has run or how much mileage is left in it. A fabric break may not be visible, yet such a break will sooner or later cause a blow-out.

Retreads are in another class. An old tire carcass, properly retreaded, looks exactly like a new tire. The tread may seem new, but what good is a tread? The tread merely protects the fabric. The fabric is the real tire. There are good treads and bad treads, and you cannot tell what you are buying by looking at the tread.

This is not condemning retreading, because a good carcass is always worth retreading. There are many concerns that retread old casings in which the fabric is still good, and in this case the owner gets good return for his money.

Here is the best advice for tire-buying: Buy the very best tires you can afford, inflate and take care of them properly, and you will get the greatest return in service for your dollars.

Doubling the Capacity of the Clothes-Closet

PERHAPS there is nothing that the housewife has wished for more often in the home than additional closet room.

The average closet is provided with hooks around the walls only. This arrangement leaves a great deal of wasted space in the center of the closet which we often wish could be utilized.



By installing this clothes-hanger you increase the capacity of your clothes-closet

hooks around the walls only. This arrangement leaves a great deal of wasted space in the center of the closet which we often wish could be utilized.

The accompanying illustration shows an easily constructed contrivance designed to make use of this wasted space in the closet, which at the same time can be easily removed when the semiannual house-cleaning time comes round.

It consists of a specially designed clothes-tree, to be placed in the center of the clothes-closet, providing a number of clothes hooks and also a place below for storing extra pairs of shoes.

Of course, the size of the hanger should be regulated to fit your own needs and the closet in which it is to be used. The one illustrated was just 64 inches from the floor to the top of the cross-bar, and was provided with an opening in the center of the upright, as shown, so that it could be lifted with ease.

After the device was completed it was given a good coat of flat white paint.—MORTIMER V. TESSIER.

Last Big Block OF THE CANADIAN PACIFIC RESERVED FARM LANDS

THIS announces the offering of the last big block of the Canadian Pacific Reserved Farm Lands. Until this block is disposed of you can secure at low cost a farm home in Western Canada that will make you rich and independent. Never again on the American Continent will farm lands be offered at prices so low.

Last Big Opportunity

This block contains both fertile, open prairie and rich park lands in Lloydminster and Battleford Districts of Central Alberta and Saskatchewan. Farm Lands on the rich prairies of Manitoba, Saskatchewan and Alberta, averaging about \$18.00 an acre. Land in Southern Alberta under an irrigation system of unfailing water from \$50 an acre up.

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The Canadian Pacific offers you this land under a plan of long term, easy payments that is remarkable in the history of farm investments. You pay down 10%. Then you have no payment on the principal until the end of the fourth year, then fifteen annual payments. Interest is 6%. In Central Saskatchewan, Seagar Wheeler grew the world's prize wheat. World's prize oats were grown at Lloydminster.

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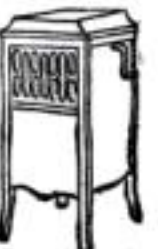
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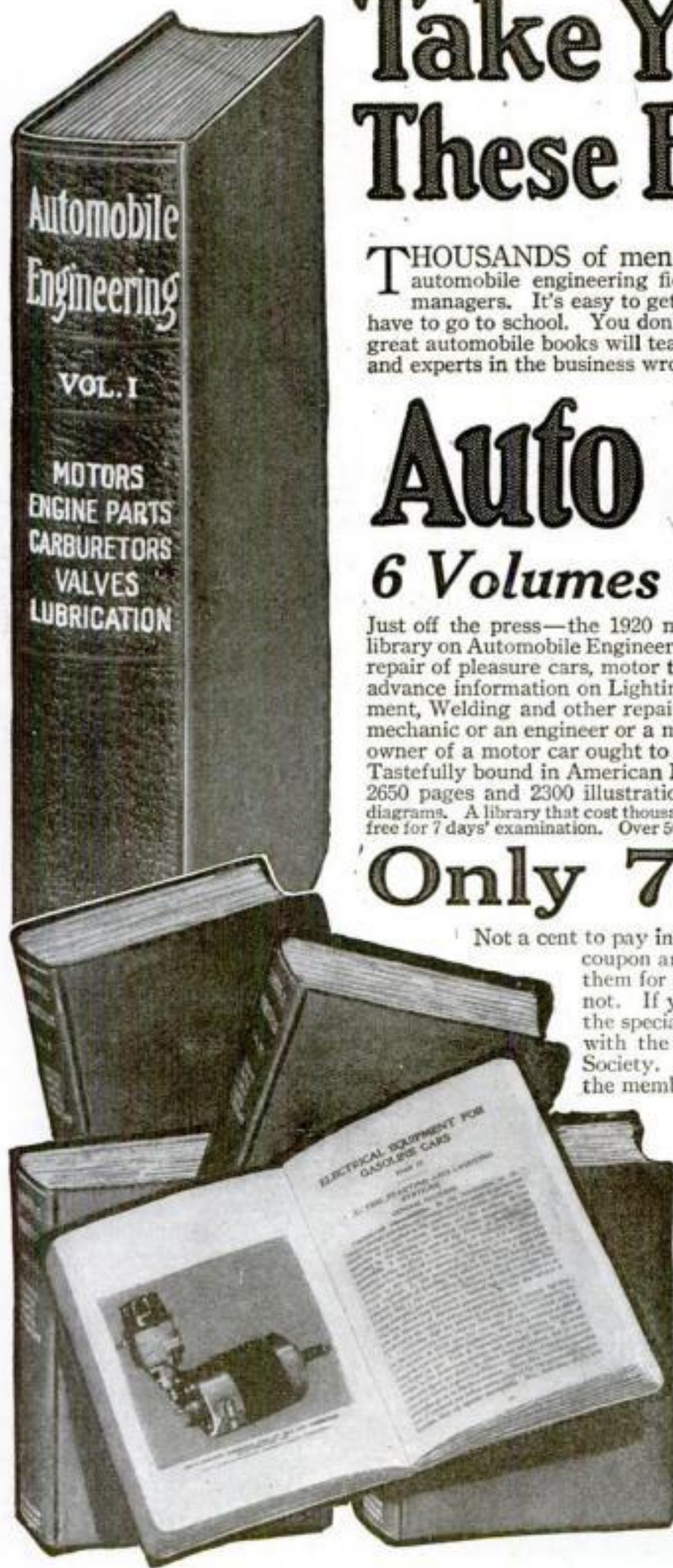
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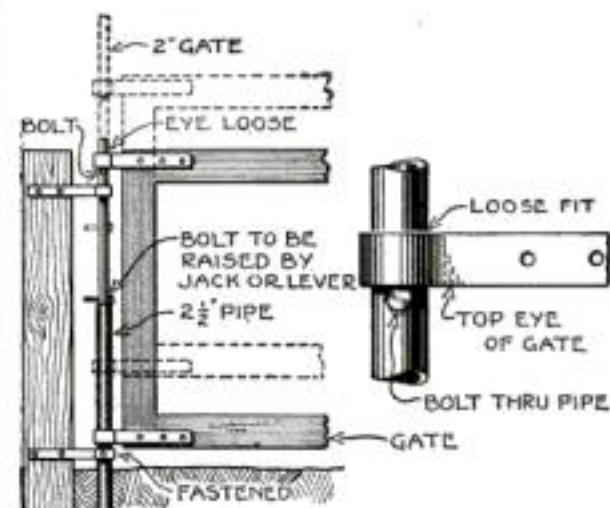
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Jack Up the Gate to Clear Obstructions

WHEN the snow flies and banks up in front of the big gate, how are you to open it or drive your team through without shoveling away the drift? With a gate like the one here illustrated you simply pump a few times on the wagon-jack, and the gate



No matter how high the snow-drifts pile, you can swing open the gate with this contrivance and drive through

obligingly moves up out of the snow so you can swing it open.

First, be sure your gate does not sag. Then have a blacksmith make four eyes of strap-iron. Bolt two of these to the top and bottom of the hinged end of the gate with heavy bolts, and file out the inside of the eyes until they are smooth.

Set a length of 2 1/2-in. iron pipe in the ground so that a part about half the height of the gate will project perpendicularly above ground. Then slide a length of 2-in. pipe inside the 2 1/2-in. piece. The bottom should touch the ground and the top reach about 2 feet above the top edge of the gate.

Use the other two eyes to strap these pipes to a solid post about 4 in. from them. The bottom eye can be tapped and bolted to the pipe if desired, but let the upper pipe slide through the top eye.

Before assembling the pipes to the post the gate eyes should have been slipped over the pipes. See that they both swing about the pipes without binding.

Drill a hole through the 2-in. pipe just under the top eye on the gate, and run a long bolt through it. Run another bolt through the same pipe just above where it emerges from the lower pipe and in line with the fence, so it projects out between the gate and the post.

A study of the diagram will explain the construction, assembly, and manner of working.

When the snow is so deep the gate cannot be swung open, simply put a jack or lever under the lower projection bolt and raise the 2-in. pipe. The top bolt, bearing under the top eye of gate, carries the gate up with it so it can be swung open above the drift.—L. B. ROBBINS.



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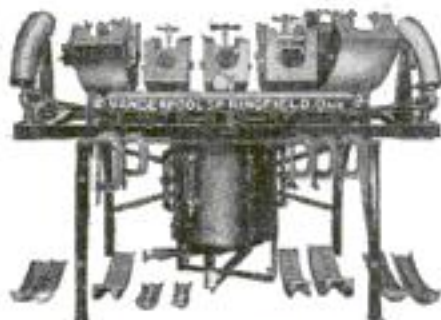


Turn a Valve and Cook or Heat

THE OLIVER OIL-GAS BURNER makes any cooking or heating stove a gas stove. Burns coal oil (kerosene). No coal or wood. Cooks and bakes better. Cheaper. Keeps your home warmer. You regulate flame. FITS ANY STOVE ANYWHERE. No fires to start, no ashes, no chopping, shoveling, poking and dragging of coal. Saves hours of work and loads of dirt. Simple. Safe. Easily put in or taken out. No damage to stove. Lasts a lifetime. Thousands of delighted users. In use eight years. Money-Back Guarantee. Free literature. **AGENTS WANTED** OLIVER OIL-GAS BURNER & MACHINE CO., 1333 N. 7th St., St. Louis, Mo. Western Orders Shipped From Frisco.

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In answering address Dept. R-20

WM. VANDERPOOL COMPANY, Springfield, Ohio

The Care and Operation of D. C. and A. C. Motors

MOTORS should be at rest when oil-wells are filled, to prevent accident and to avoid a false oil level, due to a certain amount of oil being carried up to the shaft and linings when the motor is in operation. Use a good grade of motor oil.

To Start Motors

First, be sure that the rheostat arm is in the "off" position. Second, close the main switch (the line switch should always be either fully closed or fully open). Third, with hand-starting devices, move the lever of the starting device firmly on to the first contact; hold it there for two or three seconds, to allow motor armature to accelerate slowly; then move the rheostat lever from one contact to the next until it is in the last position, where the magnet will hold it.

To Stop Motors

First, open the main switch. Second, be sure the starting lever is returned to the "off" position by the time the motor stops.

If any of the contacts arc, they should be cleaned with sandpaper. See that the brushes move freely in the holders and at the same time make firm, even contact with the commutator. The commutator should be kept perfectly clean.

In case the commutator has become rough, prompt attention should be given to avoid undue sparking, heating, and similar troubles. The roughness may be removed by polishing the



Do you know how to care intelligently for an electrical motor? Here is some common-sense advice

commutator with a piece of sandstone from which a segmental piece has been cut having the same radius as the commutator. Sandpaper may be used by pressing it against the surface of the commutator with a block of wood shaped like the sandstone mentioned. In both cases the commutator should be run at a high rate of speed during the polishing, and the sandpaper should be moved back and forth along the surface,



Dentists Now Urge

A New Teeth Cleaning Method

All Statements Approved by High Dental Authorities

Leading dentists all over America are urging the adoption of a film-removing tooth paste.

Millions of people have already proved it. In every circle nowadays you see white, glistening teeth. Ask about them and the owners will say, probably, that Pepsodent has done it.

By Fighting Film

Those results come from fighting film—that viscous film which ever forms on teeth. Most lack of luster is now traced to that, also most other tooth troubles.

Film clings to teeth, enters crevices and stays. The tooth brush does not end it. The ordinary tooth paste does not dissolve it. So much of it stays and hardens, until you have it taken off in the dentist's chair.

Film is what discolours—not the teeth.

It is the basis of tartar. It holds food substance which ferments and forms acid. It holds the acid in contact with the teeth to cause decay.

Millions of germs breed in it. They, with tartar, are the chief cause of pyorrhea. All these troubles have been constantly increasing for lack of a film combatant.

The Way is Found

Dental science, after years of searching, has found a way to fight film. Five years of clinical and laboratory tests have proved it beyond question.

For home use the method is embodied in a dentifrice called Pepsodent, made to meet every dental requirement. And to make it known quickly in every home, a 10-Day Tube is being sent to everyone who asks.

A Quick, Convincing Test

The Pepsodent results are evident and quick. A ten-day test will leave no doubt about them. And a book will tell the reason.

Pepsodent is based on pepsin, the digestant of albumin. The film is albuminous matter. The object of Pepsodent is to dissolve it, then to day by day combat it.

A new discovery makes this method possible. Pepsin must be activated, and the usual agent is an acid harmful to the teeth. But science has found a harmless activating method. Now

active pepsin can be constantly applied, and forced into every hiding place of film.

Send the coupon for a 10-Day Tube. Note how clean the teeth feel after using. Mark the absence of the viscous film. See how the teeth whiten as the fixed film disappears.

Look at your teeth now, then look in ten days. Let your own teeth decide between the old ways and the new. This is important. Cut out the coupon so you won't forget.

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stain or rubbing, penetrates, scatters the congestion, and produces a warm tingle of comforting relief.

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Sloan's World's Liniment

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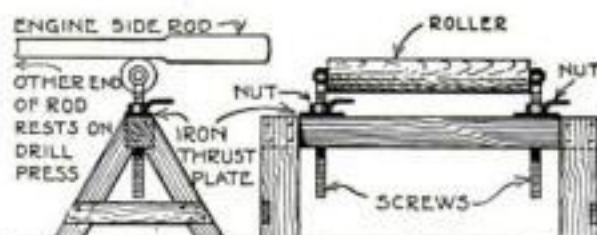
parallel to the shaft. Then carefully wipe off the commutator and brush surface to remove grit. Never use emery-cloth. If this treatment does not remedy the trouble, or if the commutator is in bad condition, call an electrician.

In the very small motors, such as those connected with adding-machines, washing-machines, etc., you will find in most cases grease-cups filled with vaseline for lubricating their bearings. They should be inspected at least once a month, and kept filled with this lubricant. The vaseline is fed to the shaft through a wick. The brushes should be taken out and cleaned occasionally.

A motor operating continuously at full load will heat up considerably. If the hand cannot be held against the heated part for longer than a minute, it is advisable to take temperature readings and report them to the manufacturer.

A Leveling Trestle for Use in Machine Work

IN the shop where I work a certain amount of work is done on engine side-rods, etc., which must be blocked and shimmed on the free end in order to level them. In order to overcome the necessity of hunting up blocks and shims of the proper size each time such



This apparatus saves man hire by making the work a one-man job; it is easy as well as inexpensive to make

work was done, a trestle was made, as shown in the diagram, which proved its worth on the first job.

The trestle was built very strong, its beam of a piece of oak 4 by 6 in. and 3 ft. long. Two holes 1 1/8 in. in diameter were bored through this beam 18 in. apart from the center and 9 in. each way. Two 1/4-in. plates were then fastened on the beam to take up the thrust of the screws, these being made from two 1-in. bolts 12 in. long, threaded all the way, and the heads forged and drilled. Two wing-nuts and a roller were then made, the roller from a piece of 2-in. cold-rolled steel. The apparatus was then complete.—O. F. GERMAINE.

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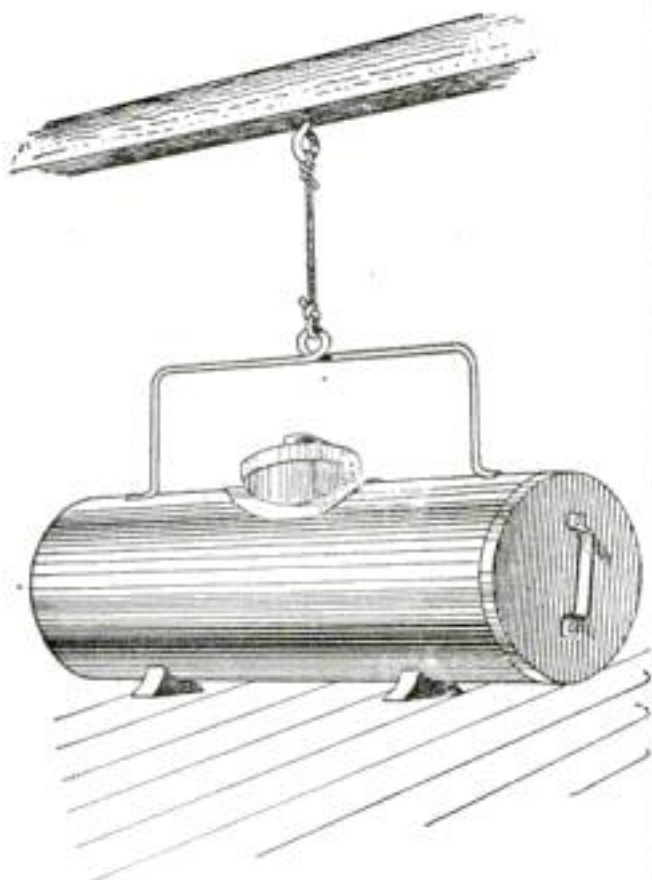
Please send, without obligation to me, your Booklet D-94, explaining your Railway Traffic Inspector's Course.

Name Address

is measured in terms of half a lifetime, and the cost is negligible.

For a churn of two and one half gallons capacity, obtain a heavy quality of block tin and shape it in an 18-by-20-in. square. Place it on 2-in. legs, arrange a handle for each end as propellers, and carve a 6-in. opening through the top for pouring the cream.

The cover to the opening fits snugly on the inside, like an old-fashioned bucket lid. A substantial



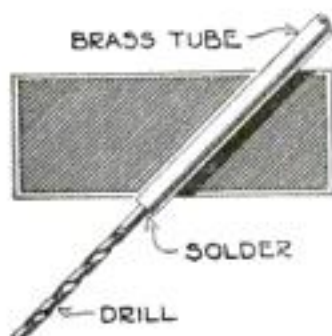
This easily made swing churn is merely shoved back and forth when it is filled with cream. It is quickly cleaned and keeps out all dust or dirt

wire handle is soldered at each end of the churn, with a ring in the center. One end of a cord is passed through the ring and the other fastened to another ring, or hook, in a beam overhead.

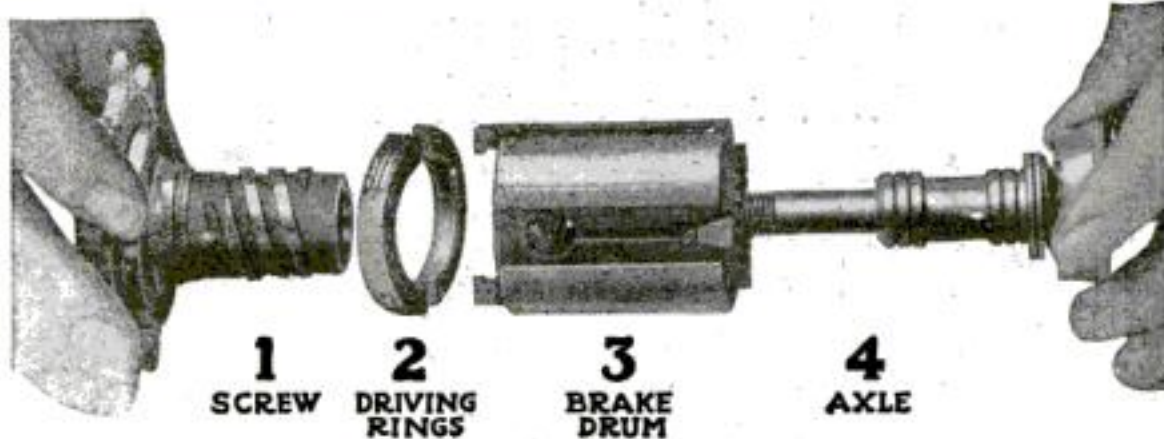
Ready for operation, the swinging device can be adjusted to any height. A small child can operate the churn, which is shoved back and forth. The sudden impact of the cream against the churn affords the friction for making the butter.—S. R. WINTERS.

Bore Difficult Holes with the Long Shank-Drill

HOW often have you tried to keep tight the bolts and nuts on your car to stop the rattle? When you tried to drill the bolt for a cotter-key, either the drill was too short or the chuck was in the way. Or, when you tried to lock the nuts on the cylinder-bolts, you could not get near them. Here is a way



If your drill doesn't reach down into that deep hole, a copper tube will help do the trick



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---and slip over them the sturdy MORROW hub (turned from solid steel) and you have as dependable yet simple a coaster brake as can be built—

Morrow STURDY, SURE COASTER BRAKE

ONLY four working units—constitute a MORROW:

- 1 A SCREW of steel, attached to the rear sprocket and which fits inside the 'driving rings' and 'brake drum.'
- 2 TWO DRIVING RINGS.
- 3 A 'BRAKE DRUM' of spring steel, carrying bronze 'brake shoes.'
- 4 THE AXLE, passing through the 'brake drum' driving rings, screw and sprocket, and about which all revolve.

Back pedaling expands the 'brake drum' and forces the bronze 'brake shoes' against the entire inner steel surface of the hub. This checks and controls the speed of your bicycle.

Forward-pedaling leaves the 'brake drum' neutral but engages two 'driving rings' which expand and drive your bicycle forward.

When your feet are idle, the 'drum' and 'driving rings' are neutral and you coast smoothly, without friction.

7 Reasons for the Morrow

- 1 Braking surface 6 3/4 sq. in.—much larger than other brakes.
- 2 'Drum' expansion forced equally by two wedges at each end, insuring even braking distribution over entire inner hub surface.
- 3 Bronze brakeshoes being softer than hard steel inner surface, grip smoothly, firmly, surely.
- 4 For forward pedaling, the Morrow responds instantly and positively.
- 5 More ball-bearings than other brakes, so coasts more easily.
- 6 The Morrow is strong and sturdy; it will stand hard wear.
- 7 Ninety-five inspections, followed by a final test, guaranteeing perfect service.

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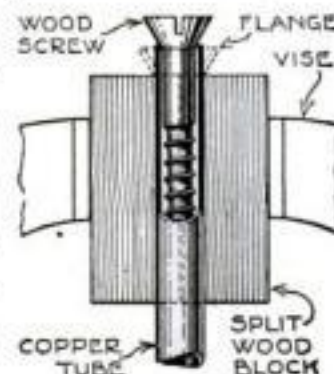
FREE

to solve these little difficulties. All you need is a piece of copper or brass tubing with an inside diameter equal to the outside diameter of the drill or a little larger. Sweat the drill into the tube by using either a torch or soldering-iron. Make it any length you want.—O. J. THIELHART.

Flanging a Copper Tube for Automobile Connections

AUTOMOBILE mechanics find it necessary to flange copper tubing to make connections for carburetors, vacuum feed systems, etc., and usually there is no equipment for doing this kind of work.

A block of wood is procured 2 in. square by 4 in. long. This is bored lengthwise in the center with a 5/16-in. drill, then cut centrally along the hole with a fine saw.

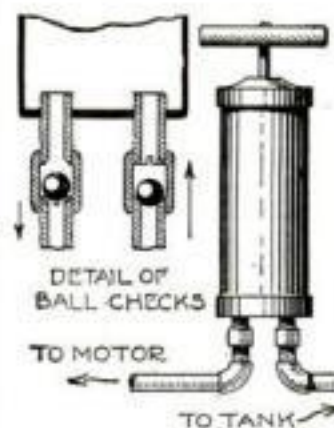


Flanging a copper tube with a screw and wood block

This serves as a clamp for holding the tube in the jaws of a vise, the tube being placed in the bore of the block, one end projecting 1/8 in. at the top. An ordinary flat-head machine screw, with a body diameter that permits fitting loosely in the tube, is dropped into the tube, the screw then being tapped lightly with a hammer. At every blow the screw turns slightly, flaring the tube end.—R. L. PRINDLE.

Make an Oil-Pump from an Old Tire-Pump

THERE are times when one desires to force an extra amount of lubricating oil into the engine. This is impossible without an extra pump, and such a one is shown in the sketch. It is made from an old bicycle pump.



Here is a way to transform that old tire-pump into an oil-pump

Cut off the pump to within about 6 in. below the handle, refit the bottom cap, and tap it for two holes, one each side of the center. Fit two ball-check valves to these tapped holes. They should act in opposite directions. In this way oil drawn into the pump from the tank cannot be forced back into it, but will pass out of the other valve into the motor. Likewise the oil cannot be drawn back into the pump, but will be again drawn from the supply-tank. This pump is inexpensive and may pay for itself in a short time.—L. B. ROBBINS.

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Making a Refrigerator that Needs No Ice

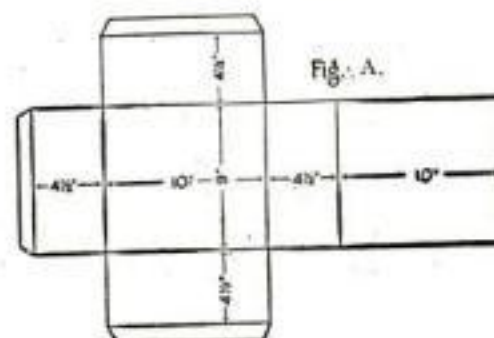
IF it were possible for you to visit an ancient Persian home you would be served with delightfully cold, pure water, in spite of the fact that your Persian host did not know what ice was.

This is accomplished by the use of a principle well known to the ancient Persians. Your host placed the water in an earthenware water jug, which being porous would become wet through. The dampness, coming in contact with the warm air outside, would cause evaporation on the outside of the vessel and the contents would become very cold.

You can use the same principle to keep the milk-bottle cold or to provide a cold drink of water. The apparatus consists of a small plaster-of-paris chest just large enough to contain two quart-size milk-bottles; it can be made by anyone who follows these instructions.

Inner and Outer Molds

Make a cardboard box or mold for the inside of the chest just $4\frac{1}{2}$ by 9 by 10 in. (see Fig. A). This mold should be thick enough to hold the wet plaster in place without bending inwards. After laying out the card to the proper dimensions, cut out around the outlines and score lightly on the outside,



A cardboard box or mold is first made for the inside of the chest

so that the corners will be straight. Bend into box shape and paste strips of paper over the open edges to prevent the plaster from getting inside the mold.

Now make an outside mold of wood (see Fig. 2), tying it down on the bottom board to keep the plaster from running out under the mold. Fasten this mold together with screws, so that you may take it apart without breaking your casting when complete. After you have marked a line 3 in. from the top all around the inside of the outside mold, you are ready to make the casting.

How to Handle the Plaster-of-Paris

Place the cardboard inside mold or core (Fig. 1) in the center of the outer mold (Fig. 2), resting on four blocks at the corners, about 1 in. square and just $1\frac{1}{2}$ in. high. Use a flatiron or other weight on top of the inner mold to keep it from floating away when you pour the plaster.

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You can do it without any question, when you once appreciate the dangerous boggy you are on and make up your mind to get off it for good and all. You can get rid of the constipation that is soaking your system with virulent poisons; you can free yourself from the digestive disorders that are making you feel like a human wreck; you can turn your watery

blood into the rich, life-giving fluid that will build up your body and your brain, strengthen all your vital organs and make a virile MAN of you again—you can do it, if you WILL to do it, and go about it in Nature's way.

Don't take the wrong turning and waste your time and money in quick "remedies" and patent medicine dope. Nature never prepared a prescription or put up a patented powder. Your violation, perhaps unconsciously, of Nature's Laws, brought you to your present condition, and she alone, through her marvelous recuperative force, can restore the manhood you have lost.

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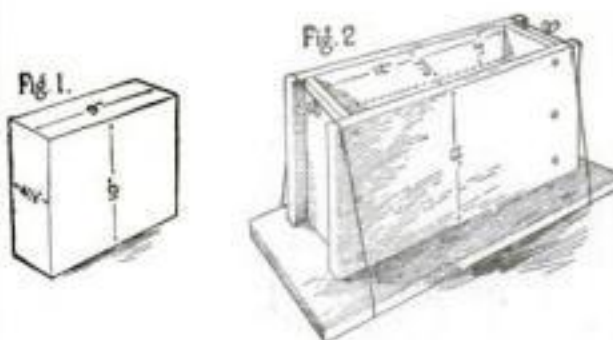
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Neuralgia .. Indigestion .. Increased Height
Flat Chest

Name ..
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plaster-of-paris, because, once you begin to mix and pour the casting, you will find no time to get more, since it dries very quickly.

Fill a large mixing-bowl half full of water, then stir the plaster in a little at a time until the mixture is fairly heavy but will run freely; then, after making sure that the mold is perfectly level, begin to pour the wet plaster. Repeat the mixing and pouring until the plaster reaches the mark you have made 3 in. below the top of the outside mold.

The casting you have just made is the ice-box of your refrigerator. Let the casting stand until the plaster is dry (about two days, for safety); then with your countersink bit, or with the end of a knife-blade, bore out four shallow holes on the top edge of the casting in each corner, to serve as register knobs on the bottom edge of the cover when complete. Now, with a little butter or lard, grease thoroughly



At the left is the box folded. At the right the completed chest, which keeps food cold without ice

the exposed top edges of the casting all around, taking care that the four depressions in the corners are well greased; remove the flatiron from the top of the inside mold; and continue the mixing and pouring until the casting reaches the top of the outside mold.

When this new section or cover is thoroughly dry, carefully remove the outside mold, and with an 8-in. bit or gimlet bore two holes down through the center of the cover for ventilation.

If the edges of the chest were properly greased the two sections of the casting should come apart with little difficulty, and you can then remove the cardboard center mold by breaking it up.

Set the refrigerator in the sink and let a gentle stream of water run on it, inside and out, until it is wet through. This is all the "ice" required, and one wetting should be sufficient for several days, the precise number of which you will be able to judge by experience. Place the milk or water in bottles inside, fit the cover on snugly, and you will be surprised to find how cold they will keep.

The device will be found useful in hot weather to keep liquids and eatables from spoiling for it keeps them cool not ice-cold. It can also be made in different sizes to suit individual by changing the form of the mold. Its cost will be amply repaid by decreased ice bills.—MORTIMER TESSIER.

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Repairing a Steam Engine Under Difficulties

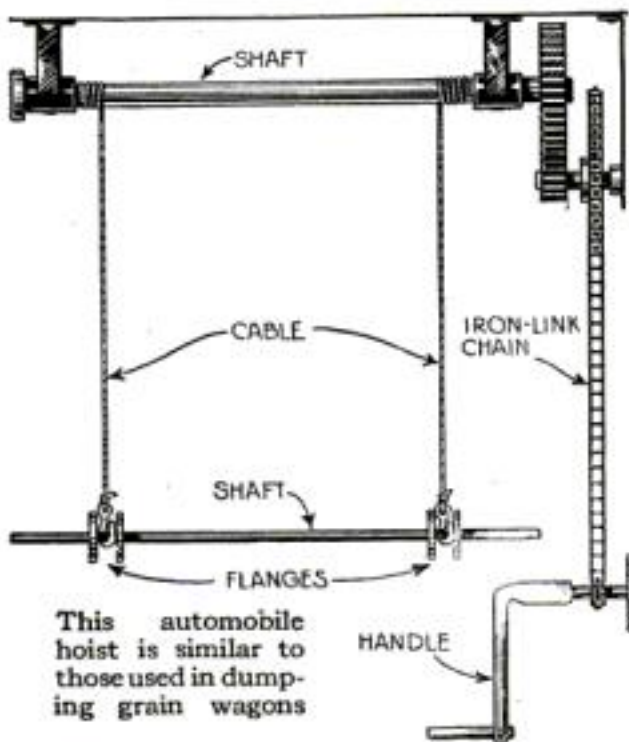
WHILE on a vacation in the Sierra Nevada mountains in California, I came upon a construction camp where the men were engaged in building a rock dam to impound the water from the winter snows for use in the gold-mines in the summertime. Their hoisting engine had broken down, and as the engineer was not a machinist, he was helpless.

I found that the connecting-rod was of the marine type, and that the two bolts on the crank end of the rod, which hold the crank brasses in place, were sheared off. This was probably due to starting the engine when there was water in the cylinder. The camp possessed a small forge, but no screw-cutting tools.

However, I determined to get the repair made somehow; so, after forging two new bolts, I clamped the threaded end of the broken bolt on to a new one, scratching each thread with the point of my knife to get the correct spacing. I then proceeded to cut the thread with a triangular saw file that happened to be in the tool-box of my automobile. By working carefully and filing at the pitch of the screw, I succeeded in threading two bolts in about four hours' time, and had the engine running again in less than six hours. The bolts were $\frac{3}{4}$ in. in diameter with about $1\frac{1}{2}$ in. of thread.—M. L. LOWREY.

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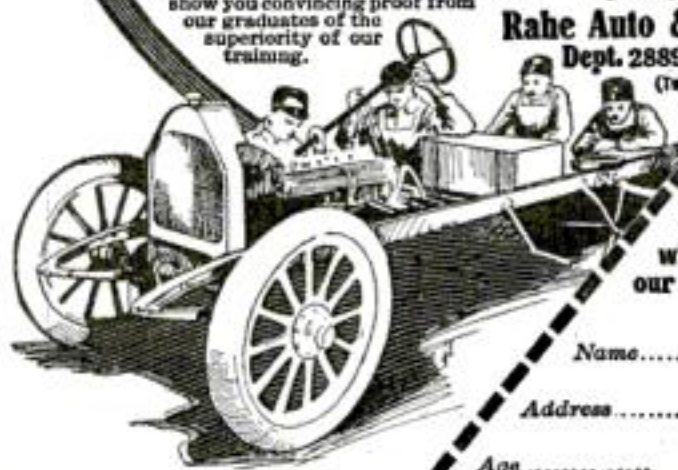
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several tons can be easily lifted. Cables carrying hooks are wound upon the shaft as the crank is turned. A piece of 2-in. gas-pipe, padded and equipped with flanges, is slipped through the spokes of both front or both rear wheels as the case may be, and the hooks attached. Padding prevents the paint from being marred and flanges keep the hooks from sliding either way on the pipe.

The device is simple, durable, and very easy to install; and with any ordinary car may be hoisted to the desired position in three minutes. When the hoist is attached to the rear end of the car the car may be raised to an angle of ninety degrees. The front end may be lifted to an angle of sixty degrees or more, depending upon the shape of the rear fenders.—PAUL L. FETHERSON.

A Novel Way to Retread an Automobile Tire

ALTHOUGH many people retread their own tires the process is generally looked upon as a waste of time because the job is so often unsuccessful. The process here described has proved satisfactory, and by following it carefully a large amount of tire money will be saved.

Take a tire with a badly worn tread. It should have good fabric and show no signs of rim-cut. The rubber must

be removed from the fabric to within 2½ in. of the bead. An old rasp will be found useful in removing the rubber. Rough up the fabric a bit to give a good hold for the cement.

The tire should then be thoroughly dried out, since any remaining moisture will cause the tread to become loose. After this is done give the surface a coat of good rubber cement.

Now split an old inner tube along the inner side, and carefully wash it out with gasoline inside and out. Then apply a coat of rubber cement to the inside of the tube and another to the tire casing, and fit the tube over the casing.

Select a tire with a good tread and cut off the beads, wash the tires thoroughly with gasoline and dry them, and apply a coat of cement to the outside of the inner tube and another coat to the inside of the outer tire. Then fit the tire over the tube, and place both upon a wheel, pump up and allow to dry. You may then remove and sew it along the edges as shown in the sketch. In this way you can utilize old tires that would otherwise be thrown on the junk-pile. When they wear out the tire underneath is still brand-new. Try the suggestion—it will save you money.—S. E. GIBBS.



Make use of your old tires and save money



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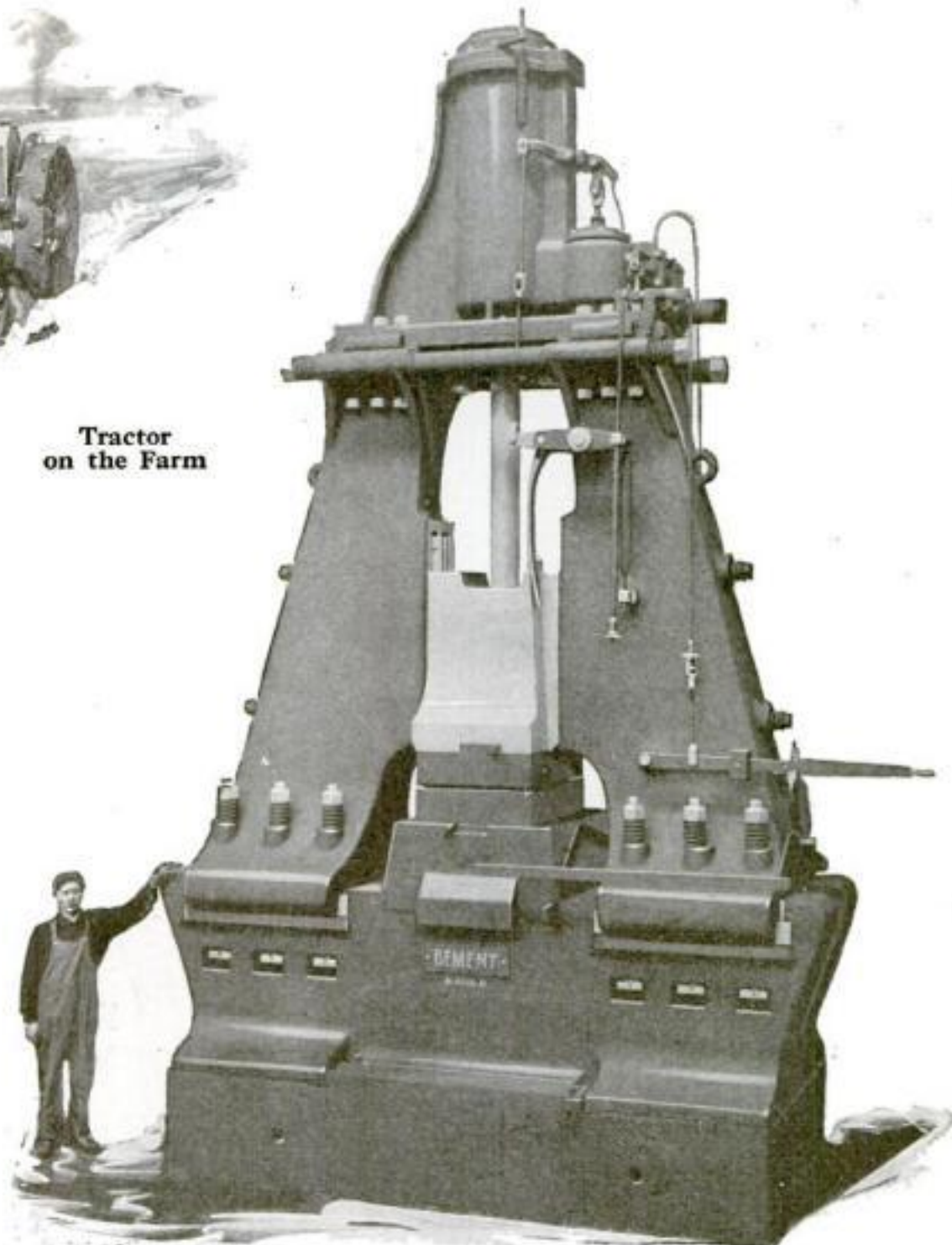
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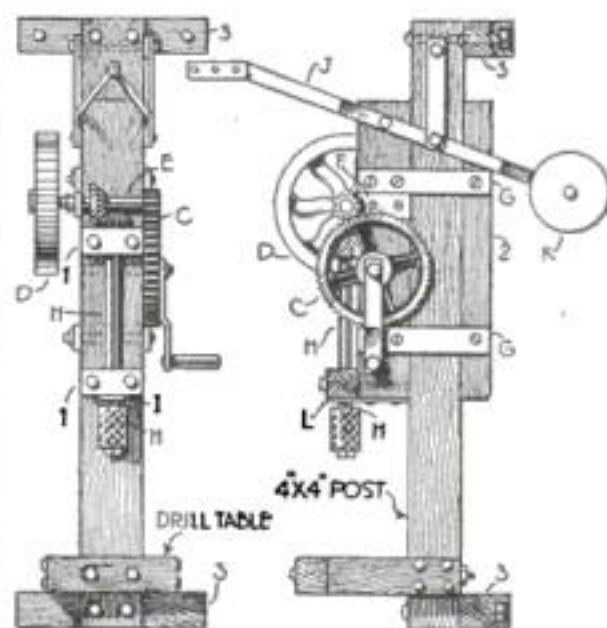
Originators of forms "Evidence of Conception."

A Drill-Press and How to Make It

THE homemade drill-press illustrated herewith is one that will actually do the work of the manufactured article, drilling holes up to $\frac{3}{4}$ in. in diameter. It can be constructed by any one who possesses an elementary knowledge of the use of tools.

The greater part of the press is made of wood, well seasoned oak being the best for the purpose. All numbered parts in the illustrations are made of wood, but cast bearings may be substituted for 1, 1, if desired.

The motion block bearings are constructed of well seasoned oak. To this is bolted the two bearings 1, 1, with two $5\frac{3}{4}$ -by- $\frac{3}{8}$ -in. machine bolts, the nuts being set in pockets as shown at H. The bearing E, forged from $\frac{3}{4}$ -in. iron, is also bolted to the motion block,



The whole machine is bolted to a strong post so that it will carry the motion block to its highest point

being countersunk into the wood at A A. At B a $\frac{3}{4}$ -in. hole is bored into which is fitted a $\frac{3}{4}$ -by-7-in. machined bolt to act as a bearing for the drive wheel C.

Shafting $\frac{3}{4}$ in. in diameter is used throughout. The gears, with the exception of C, are fastened to their respective shafts by means of 1-in. pins, riveted. The holes in the gears are countersunk. The flywheel D is fastened to shaft E with a $\frac{1}{4}$ -in. pin, being only slightly riveted. The end thrust of shaft E is taken up by spacing washers placed between the hub of D and the arm of bearing E. The bearing blocks 1, 1 are drilled for shaft B, the hole being $1\frac{1}{4}$ in. in diameter. These holes are roughened and made larger in the center than at either end. A few pins of iron with rough heads are also driven into the walls of these holes. The shaft E is then put in place, lined up so that it is exactly perpendicular to the drilling, and molten babbitt poured into the bearings.

The four pieces C are now fastened to the motion block. These are made of $\frac{1}{2}$ -in. iron and are fastened to guide block 2. All parts subjected to the reciprocating motion of this block



should be carefully shod with $\frac{1}{8}$ -in. sheet iron which is fastened to the wood with wood screws, countersunk—or angle-irons may be put on all corners subjected to motion. This is not shown in the drawings.

Any standard drill chuck may be used at *H* or a chuck from an old carpenter's brace may be used; in fact this is to be preferred because square shank drills are much cheaper than other kinds.

Between chuck *H* and thrust bearing *I* are placed several machined spacing washers. The thrust bearing is fastened into place after shaft *I* is in position.

The drill is fed by means of a lever *J*, which is made of $\frac{3}{16}$ -in. iron in the shape shown. On the back end is placed a counter-balance *K* to restore the motion block to its original position after drilling.

The fulcrum rods *L* are made of $\frac{3}{4}$ -in. iron about 9 in. long. There are two of these, one on each side, and they are fastened at the top end by a bolt, and so secured that they move freely as illustrated by the dotted lines. All the feed lever parts should be neatly adjusted, washers being used where spacing is necessary. The whole machine is bolted to a strong post 4 in. square by blocks 3-3. Counterbalance *K* is then fastened on 3 behind the plank, to which the machine is bolted so it will easily carry the motion block to its highest position.

The drilling table is strongly made from oak and is fastened to the drill post by six bolts. Under gear wheel *C* a large washer is placed and a suitable handle bolted on.

The gears used in the above-described machine were taken from an old washing-machine.—W. L. STEVENS.

Why It Is Your Automobile Radiator Boils

THERE are three principal causes for the boiling of the water in a motor radiator and the consequent necessity and annoyance of frequently replenishing it.

The fan belt slips, the pump does not work, or the ignition system is not correctly timed. If, after assuring yourself that the fan belt is tight and the pump works properly, the heating continues, you may be practically certain that the magneto is not timed right. The spark is too slow. It comes slightly after the point of maximum compression, with a resultant loss of speed and power, an excessive consumption of gasoline and rapid heating of the water in the cooling system.

Unless you have an instruction book describing very carefully the process of retiming an ignition system, you had better have this done by an expert at some garage. Like a skilled physician he can instinctively feel the "pulse" of your motor and diagnose its ills and cure.—FLOYD L. DARROW.

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Miracle Motor-Gas is a big money saver for the motorist. You will be surprised, then gratified at the way it multiplies the power of your gasoline. Hundreds of our customers who have made many tests tell us that Miracle Motor-Gas gives from 15 per cent to 40 per cent more mileage from every gallon of gasoline. Many claim even greater results than that.

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What Miracle Motor-Gas Will Do

One hundred Miracle Motor-Gas Tablets will make 100 gallons of gasoline do the work of 133 gallons; will give you an increased power and mileage the equivalent of 33 gallons of gasoline. Figuring on this basis, the following shows what a big saving can be made by using Miracle Motor-Gas Tablets:

If from 100 gallons of gasoline you get 1500 miles, the addition of 100 Miracle Motor-Gas tablets will increase that mileage to 2000 miles. Think of it—500 miles for one dollar.

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It will eliminate carbon and make your motor run better in every way. Miracle Motor-Gas is needed the year 'round, but it is especially needed in winter for it insures easier starting and quicker pick up.

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Motorists in every section of the country have put Miracle Motor-Gas to the severest of tests with the result that they are re-ordering it and recommending it to their motorist friends.

Our files are actually crowded with unsolicited letters endorsing this great discovery. Many of them state our claims are far too modest; some going as far as to say that Miracle Motor-Gas saves them 50 per cent in gasoline.

After one trial you will be just as enthusiastic as the thousands of other motorists. You are losing money every day you delay the trial.

Easy to Sell! Profits Come Fast! One Man Made \$210 in One Day

Once you get started selling Miracle-Gas you will be surprised to find how easy it sells. Just show our Guarantee to some auto owner and ask what he would give for a product that would do what we guarantee it to do. Read again these letters from users—they tell the story. We have hundreds more just like them. As soon as auto owners find what Miracle Motor-Gas will do, they scramble to get a supply. You don't have to sell it. You only need to convince a few—the others will follow. Sales come so fast that you can't help but make money. One agent felt like pinching his own arm to see if it was really himself who was making so much money. It isn't at all unusual for our men to make \$10, \$25 and \$50 per day. Some do better than that.

These are extracts from actual letters received from

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One of the greatest money-making opportunities ever dreamed of is offered you right now. Live, hustling sales agents are wanted to sell Miracle Motor-Gas in every town and country of the United States. Think of the millions of car owners and every one a good prospect.

Practically every auto driver will buy when once you have

explained what Miracle Motor-Gas will do. It is one of the biggest money-makers you can find. Your field is unlimited. There are thousands of autos all around you and you can help to make every one of them run more efficiently with Miracle Motor-Gas.

Next comes this letter from Dave Isom: "My whole heart and soul are in this work. The Commercial Club of 4,000 members is boosting for me. Everyone is well pleased. Have two more men working for me. Send me 800 more packages by express. I can't afford to be waiting for goods. Sold 90 packages yesterday." (That's over \$60 profit.)

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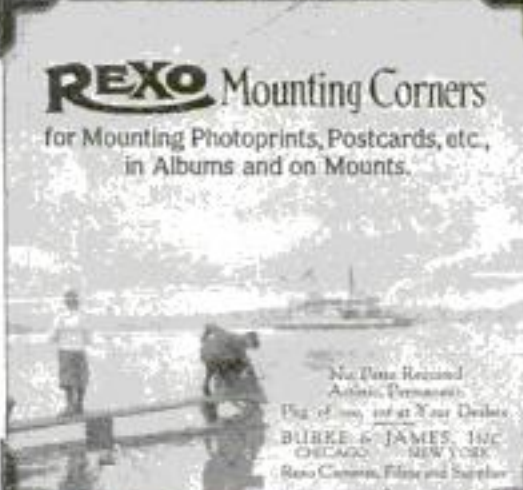
Don't make the mistake of being a doubter and losing the opportunity. Our guarantee protects you. Or, better still, if you order two packages at the 50¢ trial price, and after testing them you aren't satisfied, send back the unused goods and get your dollar back. Miracle Motor-Gas is a proven proposition. It has demonstrated what it will do and now

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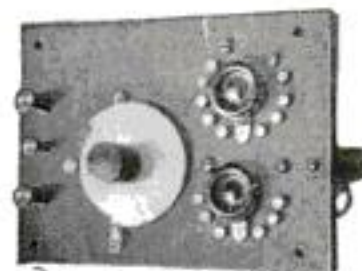
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For the Radio Experimenter

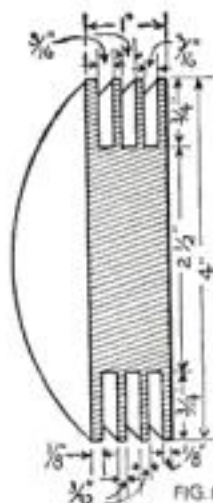
A Simple Undamped-Wave Receiving Set for the Amateur

WITH the increasing number of undamped stations comes a desire on the part of every radio amateur for a set suitable for continuous wave reception. But the cost of a long-wave coupler and several variable condensers usually puts this out of the possibilities of the experimenter. Here, however, is a set inexpensive as to first cost, and requiring but one inductance and one variable condenser.



Exterior view of the receiving set complete. All parts homemade

The core for the inductance is turned out of hard wood to the dimensions shown in Fig. 1. It is then wound with 1,000 turns of No. 32 single-cotton-covered wire. Two hundred turns are wound in the first

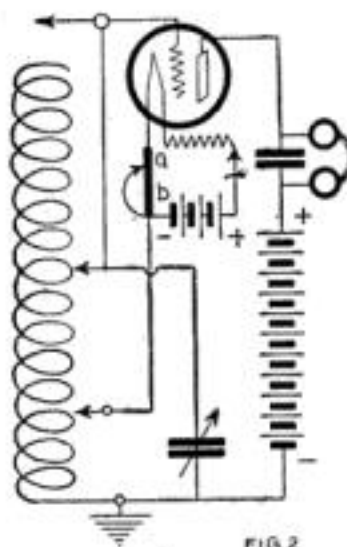


Dimensions for the inductance coil of the set

slot, taps being taken off at every twenty turns. Eight hundred turns are then wound in the two remaining slots (400 turns per slot) with taps at every 100 turns.

The first set of taps are connected to the eleven contact studs of the switch represented by the lower of the three arrows in Fig. 2. The other sets of taps (those of 100 turns) are connected with the nine studs of the middle arrow. The winding should be given a layer of tape, and shellac used freely on all parts.

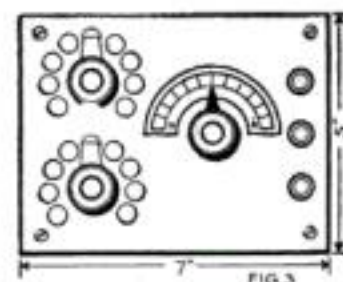
The diagram of connections is given in Fig. 2. The coupling between the plate and grid circuits is controlled by the two arrows just mentioned. The variable condenser determines the frequency of the local oscillations. It should be of the 43-plate type, and



Wiring diagram used in hooking up the parts

have a capacity of .00095 or .001 Mfd. Note that no grid condenser is used.

The grid is held at a definite negative potential by the resistance drop over "ab." This is a short strip of German silver wire whose length is varied until a position is found for best oscillation. Once made, this adjustment is permanent for a given vacuum tube. The inductance and condenser may be mounted in a small case and used with a purchased audion cabinet. The front board of such a case is shown in the illustrations herewith. All the materials used are easily within the reach of any amateur. At no place is the construction difficult nor the making of the various parts at all complicated. By reading the foregoing and carefully studying each diagram and illustration everything will become clear and the radio amateur will have no trouble in either constructing or wiring it together.—E. J. STERBA.



Dimensions of the front panel as actually made

Clearing Up the Radio Patent Situation

ANNOUNCEMENT has recently been made that the Marconi Company and the radio interests of the General Electric Company have been combined in a new organization to be known as the "Radio Corporation of America."

This means that the patents of both will be utilized to the limit. The Marconi Company owns the Fleming valve patent and others of value, while the General Electric Company has done a great deal of work on vacuum tubes and related apparatus. It has also developed the Alexanderson high-frequency alternator, a contrivance originally fathered by Fessenden.

One of the principal reasons back of the General-Electric-Marconi merger was the fact that about 18 per cent of the Marconi's capital stock was owned in England. The Radio Corporation now acquires that stock, along

with other assets, making the new company an all-American concern.

The Western Electric Company has acquired de Forest patents, and has many of its own. Thus these two concerns and the International Radiotelegraph Company, which is a patent-holding organization, promise to be the three big rivals in the radio field very shortly. The Navy Department owns the Federal Electric's arc system, in itself a very valuable holding.

The complicated patent situation that grew out of the war is gradually sorting itself out.

A World-Wide Experiment in Radio Transmission

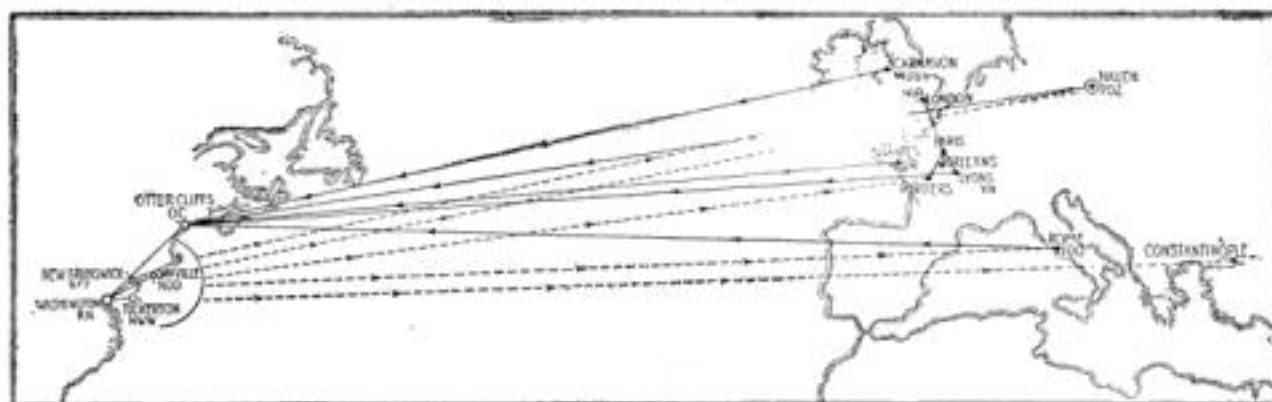
THE eclipse of the sun by the moon on May 29, 1919, offered an unusual chance to study the effect of daylight and darkness on the intensity of radio signals. The British Association of Science arranged for certain stations to transmit and others to receive.

It appears that on the whole transmission was best just before, or during, the passage of the moon's shadow between the receiving station and the transmitting station. The moon's shadow traveled from South America

at sunrise to the eastern coast of Africa at sunset, moving with enormous speed near the ends of its path.

The most striking results were obtained by the French stations of Meudon and Rousillon, near Lyons, which could hear Ascension only while the eclipse was in progress.

How the Navy Operates Its Stations



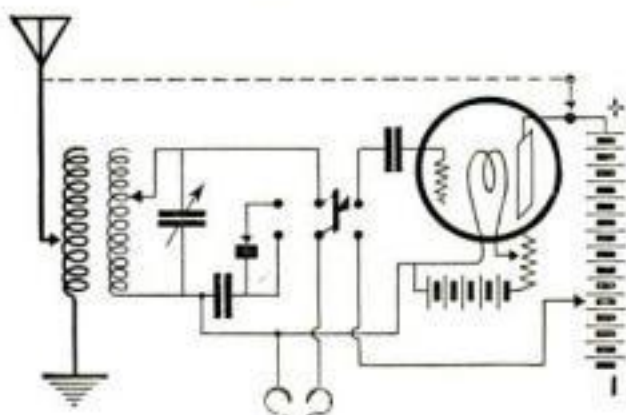
The black lines show messages coming from Europe to the Otter Cliffs, Maine, receiving station. Messages are relayed over and wires to Washington by automatic machines. Washington replies by working the Sayville, New Brunswick, or Tuckerton stations through remote control. In this way the whole situation is under instantaneous control of the Washington operators

Switch from Valve to Crystal at Will

A SIMPLE and efficient method of connecting the receiving tuner to either a valve or crystal detector requires but one switch for the operation, enabling a radio experimenter to have both types of detector in service, using a crystal for general work, and keeping the valve for more important receiving.

Ordinarily this idea necessitates the use of two or more switches, or, where one switch may have been used, causes some loss through dead-end effects.

The switch for the proposed circuit may be of the ordinary double-pole, double-throw type, as shown in the diagram. Preferably, though, it is of



Experimenters possessing both a crystal and tube will find this circuit a very convenient one

the kind known as a "pole-changer," as this may be built on the front of the receiving cabinet in a space about an inch square.

The "pole-changer" has two levers, connected by an insulating bridge carrying the handle. At the rear are two contacts, each connected to one of the levers. Each lever slides over two contacts at the front. These can be made of six old-type switch points, two small strips of brass, and a piece of hard rubber or bakelite (for the insulating bridge and handle).

The whole is then set on the front board of the cabinet with all connections completed on the rear of the board.

For continuous wave receiving on the valve, all that is necessary is to run a lead from the "aerial" post of the tuner to the plate lead—producing the well known Chambers circuit. By having a small single-pole switch placed as close to the plate lead of the valve as possible, undamped waves up to the full wave-length of the tuner may be received when this switch is closed. The position of this added lead is shown by the dotted line in the drawing.

A cabinet receiving set, equipped with valve and crystal detectors, using this circuit makes an ideal receiving outfit. Amplifying valves may be added, as in other valve circuits, and on the crystal side other crystals or a potentiometer may be connected. Radio experimenters in general may find other advantages.—GEO. A. WOLF and CHARLES E. PEARCE.

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Know the Electron—You Meet It Every Day in Radio

THE following are some notes on the electron taken from a chapter on that subject in a newly published book, "Realities of Modern Science" (Mac-Millan & Co.), by John Mills, a scientist who has written much on this and related highly technical subjects. Radio students will do well to read the entire book, as it correlates and makes understandable many laws and theories too often thought unrelated. Especially is the part on the electron worthy of attention. Electron theory is entering into an increased number of phases of radio in these times.—EDITOR.

IN finding how the matter of the universe is composed, scientists have at last reached the electron. In terms of it they can explain fairly well everything else, or at least there is promise that ultimately everything else will be so explained.

That the electrons are really mere specks in this universe of ether we realize readily from the statement that the radius of an electron is probably not larger than 2×10^{-13} cm. and that of a hydrogen atom is about 2×10^{-8} cm. The whole atom is perhaps one hundred thousand times as large in diameter as the electron. In other words, the radius of the electron is about as large, compared to the radius of the atom, as is the radius of our earth as compared to the orbit in which it travels around the sun.

In the case of atoms there are two ways in which electrons may be obtained. In the first case we may jar electrons loose from the atom. In the second case the electron may be thrown off by some disturbance having its origin in the atom itself. In this second case we call the substance "radioactive." Of such substances radium, discovered in 1897 by Monsieur and Madame Curie, is the best example. Other radioactive substances are uranium, thorium, actinium, and polonium. The atoms of such substances appear to be disrupting; not that all of them do so at once, but that of a bit of such a substance some of the atoms are always breaking down in this way. In such a breakdown electrons are shot out or other changes take place, and the result is new elements. Radium is believed to be a product due to the disintegration of uranium, and this may later be found true of the other radioactive elements.

Uranium, which is the heaviest known atom, has at least ninety-two electrons; that is, it has ninety-two electrons exclusive of any that may be contained in the nucleus, the construction of which we are about to consider. Between hydrogen, with only one electron, and the unstable uranium, with its ninety-two, lie all the possible elements. If one considers that an atom must have a whole number of electrons, it will appear that the other eighty-four known elements may fit in between hydrogen and uranium and still leave six yet to be discovered.



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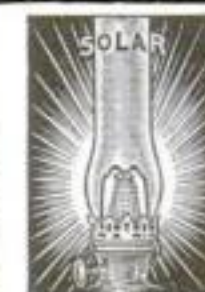
ROUGH ON RATS



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The terms "Negative and Positive Electricity" were introduced by Benjamin Franklin about 1756, long before the electron was known, for our knowledge of the latter has all developed since Roentgen's discovery in 1895 of X-rays. The reader probably knows about X-rays as a means of taking pictures of bone or teeth for surgical diagnosis. In Franklin's time it was known that if a glass rod is rubbed with silk it is electrified; that is, it acquires the ability to attract light particles, as bits of paper or pith balls. Two pith balls electrified by contact with the rod are found to repel each other. On the other hand, a rod of sealing-wax that has been electrified by rubbing it with cat's fur will produce effects similar to those of the glass rod. But there is an important difference. A pith ball charged by the glass rod and one charged by the sealing-wax will attract each other. These phenomena may be summarized in a simple law, namely, like electricities repel and unlike attract. To the electricity of the glass rod Franklin gave the name "positive" and to that of the sealing-wax, the name "negative." However charges of electricity are produced today, we still use these names.

Returning to our consideration of the atom, we may now summarize as follows: (1) the normal state of an atom is uncharged; (2) the atom consists of a number of electrons, and a nucleus which has a positive charge just equal to the negative electricity of the electrons; (3) the operation of charging a body with electricity consists in causing either an excess or a deficiency in the number of electrons in the body.

Commonly Accepted Evidence

The nucleus attracts the electrons, and they are in general very firmly held in the atomic radius. But why doesn't the attraction that exists between the positive nucleus and the negative electrons draw them together? To this question the scientist has as yet been unable to obtain an entirely satisfactory answer. For this and other questions we must await either further theories or more experimental evidence. The statements, however, that we have so far made as to the nature of the atom are supported by experimental evidence and are commonly accepted.

The nucleus we recognize as positive electricity; but we mean thereby merely that it has an excess of positive electricity over any negative which it may also include. In fact, there is evidence that the nucleus itself contains some electrons. In the case of radioactive substances we find that electrons are shot off, and also atoms that we recognize to be helium. Helium is a light monatomic gas, twice as heavy as diatomic hydrogen. Its atom consists of a nucleus and two electrons.

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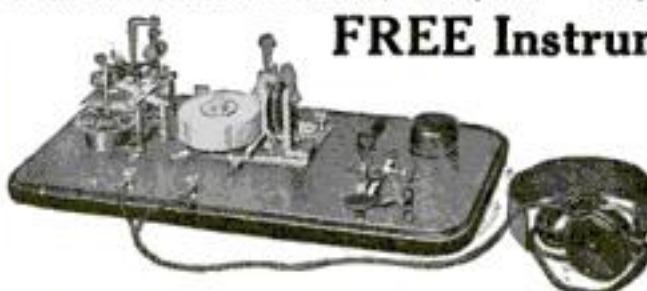
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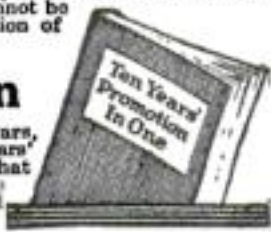
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THE LAW TRAINED MAN

The question of how the electrons of an atom group themselves under the action of their mutually repellent forces and the attraction of the nucleus is a difficult problem of mathematical physics. An interesting study has been made, however, of the manner in which a number of similar particles, which repel each other, would group themselves in a plane, under the action of a centrally located source of attraction.

In this experiment a number of small magnetic needles were first mounted vertically through small cork and thus floated on the surface of a vessel of water. Similar poles of the needles projected upward through the corks. A long magnet was suspended vertically above the vessel, so that a pole of opposite character to those of the needles might act as a center of attraction.

It was discovered that the configurations into which the floating poles grouped themselves depended upon their number. Thus three poles placed themselves at the corners of an equilateral triangle, the center of which was just below the attracting magnet. Similarly four magnets group at the corners of a square and five at the vertices of a regular pentagon.

When six magnets enter into the configuration, one goes to the center, immediately below the pole of the large magnet, the other five forming a pentagon. With seven and eight, similar figures are formed with one magnet at the center. With nine there are two in the center and seven in the outside ring. With ten or eleven there is an inner triangle and an outer ring of either seven or eight.

The number in the center increases until, when the total is fourteen, there is a pentagon inside and a ring of nine outside. In other words, as the number entering into the configuration is increased, certain arrangements recur. When the number is increased to fifteen, there is an outer ring of nine, an inside ring of five, and in the center of this a single magnet. As the number of magnets increases certain configurations appear more or less periodically, that is to say, at definite intervals.

It is reasonable, therefore, to expect, as prominent scientists have done, that, whatever the positive nucleus of the atom may be, atoms differing in their compositions by definite numbers of electrons may, in part, have similar configurations for their electrons.

In so far as the electron configuration, as well as the number, determines the characteristics, such atoms should have certain similarities in chemical properties. If a list is made of atoms in the order of the number of electrons they contain, those of similar properties might be expected to occur periodically in the list.

Win a \$500 Scholarship

To encourage schools to make practical application of their class work and to popularize science, Popular Science Monthly will at the end of this school year, award 10 scholarships of \$500 each to high school students.

Entrance Date Extended to April 1, 1920

Because so many ambitious students who wish to enter this contest did not get their names in on February 1, Popular Science Monthly has decided to extend the date for entries for these scholarships to April 1, 1920.

Conditions

The following are the conditions for winning one of these scholarships:

- 1.—These Scholarships are open to Seniors in all High Schools and Private Schools in the United States.
- 2.—Names of Candidates, giving their school and their home address, must be mailed to Scholarship Committee, Popular Science Monthly, 225 West 39th Street, New York City, by the principal or headmaster of the school on or before April 1, 1920.
- 3.—The Scholarships will be awarded to the candidates passing the best examination on the important new scientific inventions and discoveries which have been outlined in the Popular Science Monthly. The examination will be given in the candidate's own school during the last week in May, 1920.
- 4.—The questions will be based on the topics in the Teachers' Service Sheets of Popular Science Monthly for the months of December, 1919, to and including June, 1920. These Service Sheets are furnished free to Science teachers.
- 5.—The examination papers will be sent to the Principal of every school where there are pupils to compete. The papers will be sent in a sealed envelope which must be opened in the presence of the candidates.
- 6.—The \$5000 will be divided into ten Scholarships of \$500 each. One Scholarship of \$500 will be awarded to one student in each of the following groups of States:
New England Group: Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut.
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South Atlantic Group: North Carolina, South Carolina, Georgia, Alabama, Florida, Porto Rico.
Great Lakes Group: Ohio, Indiana, Michigan.
Central Group: Illinois, Wisconsin, Minnesota.
Prairie Group: Iowa, Missouri, Kansas, Nebraska, South Dakota, North Dakota.
South Central Group: Arkansas, Mississippi, Louisiana, Oklahoma, Texas.
Western Group: Wyoming, Montana, Colorado, New Mexico, Idaho, Utah, Arizona, Washington, Oregon, Nevada, California, Hawaiian Islands.
- 7.—The Popular Science Monthly reserves the right to publish the answers together with the names and photographs of the winners of these Scholarships.
- 8.—Winners may select any College or University they wish to attend.

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How to Locate Instantly a Particular Drill

AMONG the labor-saving tools in my collection is a unique drill-case which at any moment locates the desired drill, yet when closed will not allow the drills to spill.

I first obtained a steel collar about half an inch wide and having an inside diameter of approximately 3 in. This was cut from a steel tube having a thickness of about 1/16 in. The collar was rough, and by means of a buffing wheel was soon brought to a polished surface. Measuring the outside circumference accurately and dividing the result by 20, I used a set of protractors, scratched the divisions, and stenciled the figures, using a steel punch and a piece of round iron about 2 1/2 in. in diameter clamped

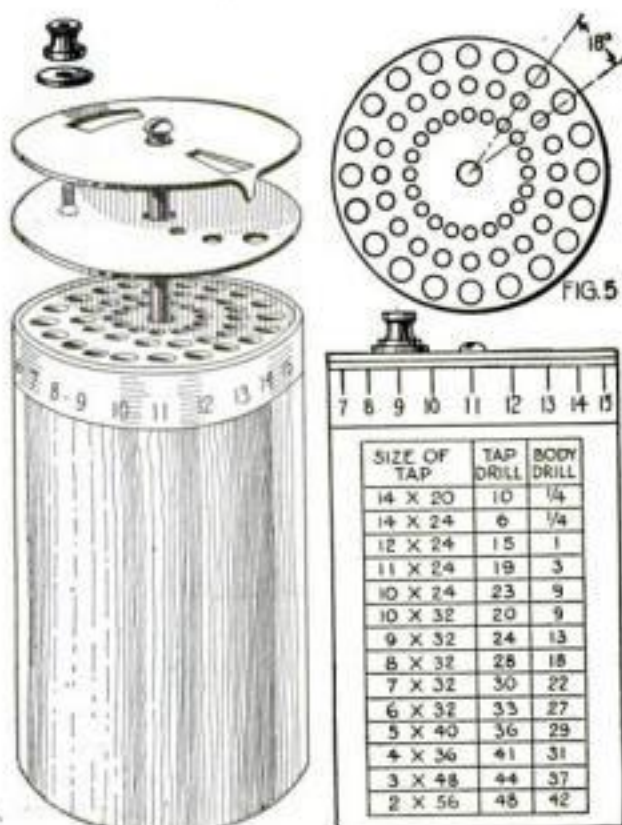


FIG. 6

With this contrivance you can easily locate and take out the special drill needed for the particular work on hand

in a vise. The divisions were numbered from 1 to 20 inclusive. (See Fig. 1.)

Next I secured a piece of hardwood 3 1/2 in. square by 5 in. long, and, centering it in the lathe, turned down one end for 1/2 in., so that the collar had to be forced or driven on. Then I turned the rest of the block down to the same outside diameter as the collar.

With the collar end down, I drilled a 1/2-in. hole about 1/2 in. deep in the center of the bottom of the block. Reversing the block, I drilled a hole with a No. 9 drill all the way through, the hole coming out in the center of the 1/2-in. hole previously drilled. (See Fig. 2.)

Out of 1/16-in. brass I cut two disks (as shown in Figs. 3 and 5). The cut shows the size of holes to drill and gives the dimensions. The three holes of different sizes on the disk in Fig. 3 should be counter-sunk on the top, and the one hole opposite, after being tapped, counter-sunk on the bottom,



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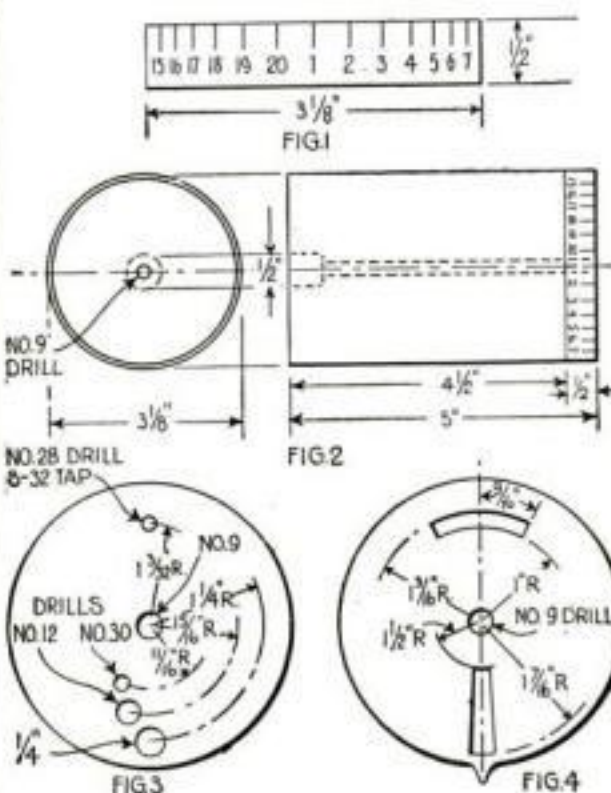
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Into this latter hole I screwed the threaded end of an 8/32-by-1/4-in. machine screw, and, turning the disk over, headed the end into the counter-sunk portion. Then I cut the head of the machine screw off, leaving a threaded stud about 3/8 in. long pro-



Showing how the drill-case is constructed, and just how it permits you to determine where a certain drill is located

jecting upright from the disk. To cut the two slots shown in Fig. 4, I drilled a number of holes and filed them out.

I then made a paper disk as shown (page 137), the dimensions from the center and the size of drills being the same as the bottom three holes in Fig. 3, and glued to the collar end of the block, being careful that the outside circle of large holes exactly coincided with the numbered divisions on the collar.

Placing it on a drill-press so as to obtain perfectly straight holes, I drilled the holes as shown in Fig. 5, being careful that the drill always went straight in the center of each hole and was not influenced by the grain in the wood.

If, however, the wood is of such grain that the drills will not run straight, paste the paper template on a small piece of brass plate and drill the holes, afterward using the brass template to guide the drills in the wooden block.

I placed a 10-by-5-in. round-headed machine screw through the center hole in the disk of Fig. 4, through the disk of Fig. 3, and down through the collar end of the block. A plain washer, a lock washer, and a nut are applied, and the end of the machine screw slightly headed over, so that the nut will not come off.

On the threaded stud of Fig. 3 now projecting through the disk of Fig. 4, I placed an 8/32-in. copper washer and a little knurled thumb-nut taken from the terminal of a dry-cell battery. The sliding of the top disk on the other disk allowed the three different size



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- 8th. Knife, Arthur Rick, 223 Mariposa St., Syracuse, N. Y.
- 9th. Scout Axe, Joseph Gerend, Box 76, S. Kaukauna, Wis.
- 10th. Watch, Albert Schulte, - - Box 364, Houghton, Mich.
- 11th. 3-Coin Bank, Stuart Demarest, - Roselle Park, N. J.
- 12th. Scout Compass, Charles E. Brady, - - Glen Ellyn, Ill.

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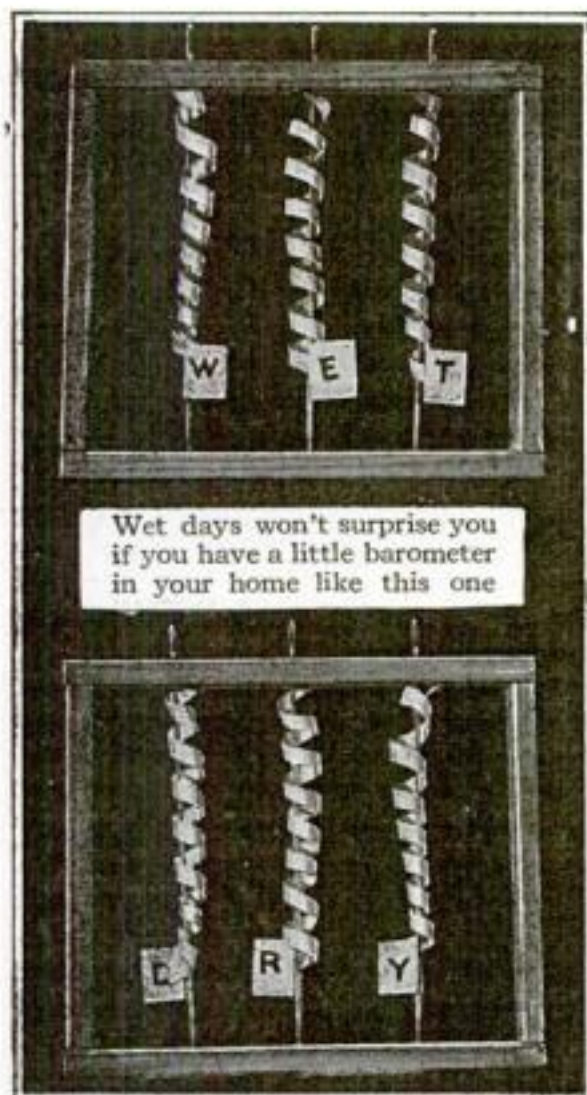
holes to appear in the slot of the top disk. Thus, if I want any drill from 1 to 20 inclusive, I set the disk so that the large hole appears and turn the pointer located on the top disk to the desired number on the collar. To obtain any drill between 21 and 40 inclusive—as for example No. 36—I subtract 20 from the number, and with the middle hole set in the slot turn the pointer to No. 16. The process for obtaining drills from 41 to 60 is identical, with the exception of using the smallest hole and subtracting 40.

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The assembled instrument is shown in Fig. 6. and the table of drills for a given tap may be stenciled on the wooden surface of the block.

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On a dry day the instrument is set to read "Dry." When rain is in the air the humidity of the atmosphere twists the tinfoil and turns the squares of paper so that they read "Wet."—M. JOHNSON.



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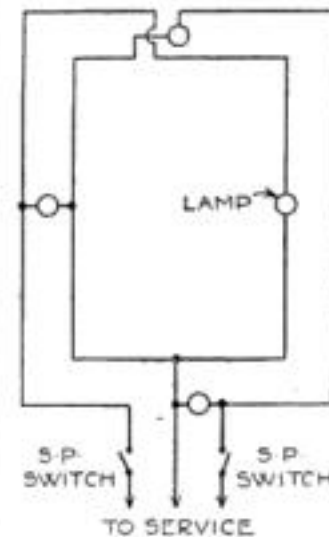


Fig. 1 shows how two lamps were wired on each of two circuits

a room in which the lamps and wires were all in place but not connected, because no electrician had been able to satisfy the customer's desire to have two lamps on each of two circuits fed through single-pole switches from a three-wire service, with no more than two wires at any part of

the room except at the entrance. The wireman finally evolved the scheme shown in Fig. 1.

Another man had four lamps in his stairway, located one at each of the four landings, which he wanted connected so that all of the lamps could be lighted or extinguished from any one of the switches located one at each of the four floors. How the electrician connected them is shown in Fig. 2. These are only two examples of the sort of thing electricians are up against every day.

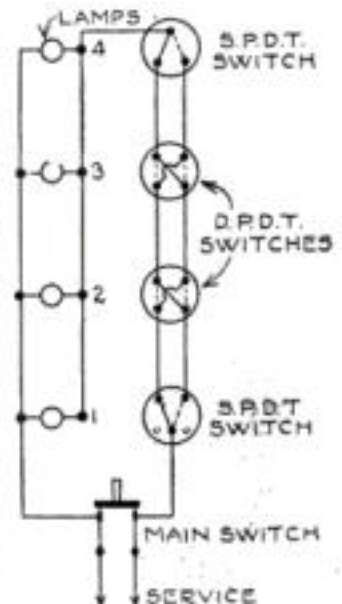


Fig. 2. How four lamps were extinguished from each of four floors

Therefore a man who follows this trade should have the faculty of resourcefulness.—FRANK GILLOOLY.

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A sheet-iron box, made to fit the opening of the furnace door, will utilize the space upon the hearth that would otherwise go to waste.

The back of this oven should project a few inches over the inner edge of the hearth, so as to receive the full benefit of the heat. As can be seen



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from the illustration, the bottom of the oven is raised slightly above the hearth, which permits the heat to circulate beneath the under side. Slides should also be so arranged that a grilled



By setting the tray in the mouth of the furnace you can use the heat for cooking

shelf can be admitted, thus utilizing both the upper and the lower parts. Handles should be attached on either side to assist in removing the oven when warm.

Save Money By Using This Tire Code

Here is a "code" for motorists which, if closely followed, will save many dollars annually in tire expenses:

Keep your tires properly inflated at all times.

Be sure to repair the little cuts regularly.

Prevent blowouts by avoiding severe jolts and by maintaining full pressure.

Have the mud boils cleaned out and repaired at once.

Be careful when inserting tubes.

Avoid sudden stops, quick starts and skidding.

Keep the front wheels in alignment.

Use talc in the casing, but don't use too much.

Avoid ruts and save the side walls.

Don't drive in car tracks.

Apply chains properly and use them only when necessary.

Avoid sharp obstructions.

Remove grease, oil and acids from your tires at once by using a cloth moistened in gasoline.

Examine clincher rims occasionally for irregularities and rust.

Prevent damage from rust by using graphite.

Carry spare tubes in a bag.

Keep the spare tires covered.

Be sure that there is nothing on the machine that scrapes the tires as they revolve.

Be constantly on the lookout for defects—then you will eliminate most of your tire trouble.



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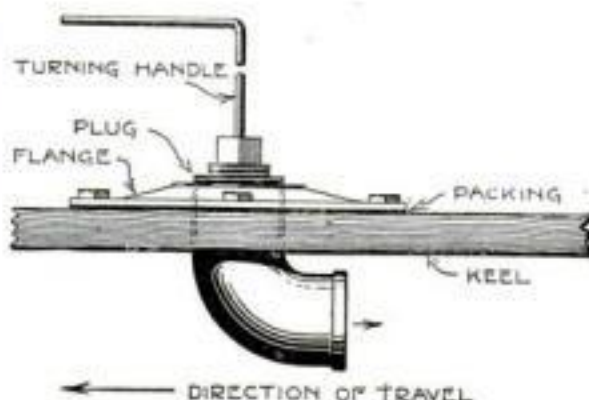
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This Boat Pump Bails when the Boat Is in Motion

INSTEAD of bailing out the boat before starting, why not install a simple bilge-pump which will empty the water when the boat is under way? It acts when the hull is moving at five miles an hour or more, and needs no



Get rid of that tin-can bailing habit by installing this automatic boat-pump in your launch; it never fails

attention other than to close it before the boat stops.

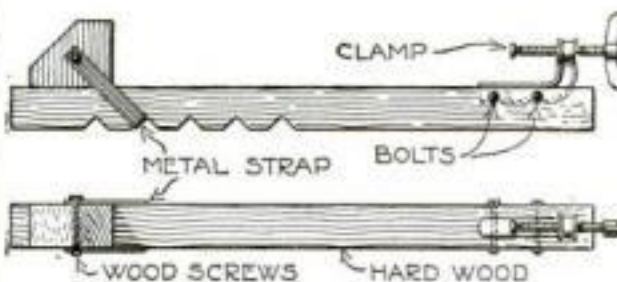
Bore a hole in the keel, and thread in an elbow as shown, directing the horizontal opening toward the stern. You can render the seams water-tight with a flange bolted to the inside of the keel-piece. Fit a plug with a turning handle, and the deed is done.

After the boat is in motion unscrew the plug, and the water in the bilge will be drawn out, due to action similar to that in a siphon. Then close it again with the plug before stopping. This is simple and will never fail.—WINDSOR CROWELL.

An Extension Clamp for the Amateur Carpenter

AN extension clamp is desired by every home carpenter, but he has been prevented from buying it on account of its high cost.

One is easily made, however, from a broken C clamp. With this, all that



Constructing the extension clamp shown here will save you buying the expensive manufactured article

is needed are two pieces of hardwood, two $\frac{3}{8}$ -in. bolts, two head screws, and a piece of metal strap. By following the accompanying illustration the clamp can be made in a very short time and will give good service for years.

Dimensions cannot be given, since the clamps come in assorted sizes; but they are unnecessary, for the clamp itself can be used and the rest of the contrivance may be made in proportion.—O. J. THIELHART.

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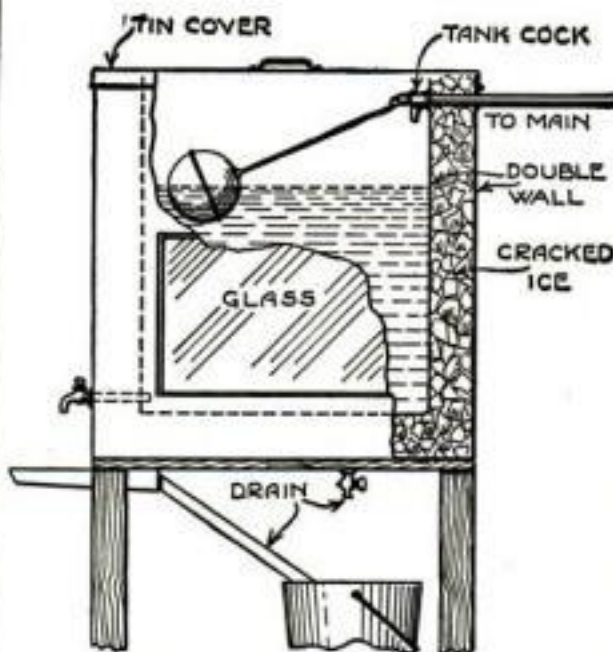
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This Ice-Water Tank Really Keeps Cold

AFTER July 1st the ice-water tank will become even more popular than it has been heretofore. There are many contrivances of this sort on the



The water tank is entirely surrounded by cracked ice, practically setting the water in a bed of ice

market, but the one illustrated is easily made, even by those with little knowledge of tools, and it will do its work efficiently.

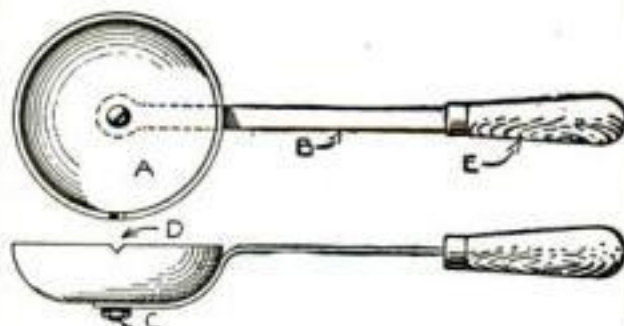
Two tin boxes are fitted one inside of the other, the ice being broken up and placed between them. A simple water trap valve controls the water level, which may be adjusted to any height desired, while a petcock in the bottom allows the water to be drained off after it has melted from the ice.

The tank can be made to look very clean and neat with a coating of white enamel and will repay its slight cost by keeping you cool and comfortable.—ROBERT SCHMITT.

A Handle Ladle Made from a Bell-Gong

AN excellent solder ladle can be made from an old bell-gong, a strip of brass, and a handle.

A is the gong, taken from an old electric bell. B is a strip of brass



Make your own soldering ladle from an old bell-gong, a strip of brass, and a handle

fastened to the gong with a small bolt, E. The dent D is made in the gong with a pair of pliers, so that the molten solder can be poured to a given place.—FERRON HIMES.



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Transportation today is the country's second largest industry. Four billions of dollars are annually spent in freight charges. Yet perhaps eight of every ten shippers are losing money. And why? Just this: few of the men now in traffic work actually know how to route, classify and pack freight to get the cheapest rates. Millions of dollars are being wasted in this way. 100,000 more competent, well-trained traffic men are needed to stop these losses. Be one of these experts and you won't have to look for a job. The job will look for you. You may almost set your own salary!

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Please send me, without obligation on my part, your free book, "Opportunities and Requirements for Traffic Work." Also tell me how I can qualify as a traffic expert.

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Or if someone should use improper language in the presence of your mother or sweetheart, could you teach him a lesson.

Or if someone says, "Let's put on the gloves"; can you do it and really take care of yourself?

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Attach a Screw-Eye to Your Key-Ring

DID you know that the ordinary screw-eye used by carpenters for fastening hooks, etc., is an excellent substitute for the corkscrew?

The writer adopted this ingenious scheme a number of years ago, and since that time has never been without one. It is invaluable as an emergency corkscrew, as well as a first aid in other mechanical ways.—R. GILL.



The ordinary screw-eye makes an excellent substitute for the corkscrew

How to Eliminate Sparking at the Brushes

SPARKING at the brushes in the operation of electrical machinery, especially D.C. machines, is a very common trouble. Faulty design or construction, and perhaps errors in assembling, are some of the causes; but the majority of cases may be classed as operating faults.

Of the purely electrical causes, the most common is the wrong position of the brushes. This may be due to the brush gear not being securely clamped and thus working around into the wrong position. Where a number of brush-holders are clamped on a single stud, alignment of the holders is essential for good commutation. Brush-holders out of line with the line of the commutator segments will also cause sparking.

Faulty field coils, due to ground or a partial short circuit, will also cause poor commutation. Re-insulation will be found necessary. A partial short circuit in one of the field coils may be found or located by noting which of the coils is the coolest.

The most frequent cause of sparking is overloading. With an ammeter in the circuit this can easily be noted. Overload sparks extend the entire width of the brushes. If the overload is increased, the sparks may cause a flash-over, that is, an arc extending from holder to holder. In the case of a motor the brush rigging may be burned and the armature damaged. In a generator it will act similar to short-circuiting the armature. Before starting the machine again the cause of the overload should be removed.

High or low commutator bars or high mica result in flashing and arcing, when not only the faulty bar but adjacent bars will become rough and blackened. High segments can be eliminated by turning or grinding the commutator. High mica can be cut off and recessed.

Dirty and oily commutators are also a common cause of sparking, and the remedy is obvious.

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A Magic Clock for Home Entertainment

FOR mystifying your audience the magic pointer is a "sure-fire hit." It is used in combination with a large clock dial having a center pin, which the pointer spins upon, and stopping at any number indicated. It tells the day of the week, the time of day, number on a card, etc., the numbers all being controlled by the clock's operator. The pointer works upon the gravity principle; that is, the lead weight *E* always comes to rest at the lowest point. Since the lead weight can be moved in a circle to different points, it is easily seen that the relation of the lead to the center of the pointer determines its position on the clock dial.

The performer is able to gage the pointer's stop by the action of spring *M* passing over a series of twelve holes



The performer spins the clock hand and demands it to stop at a certain numeral asked for by the audience. How does he do it?

in *B*. To start with, the pointer is set at a certain number, and if any other number is required all the performer does is to turn the center portion of the pointer over a required number of holes.

The actual making of the clock can best be understood by following the details set forth below. The parts are made from odds and ends of old material.

A is the pointer. It is filed down from $\frac{1}{32}$ -in. sheet brass. The $\frac{1}{4}$ -in. hole in its center must balance the pointer accurately.

B is a piece of $\frac{1}{32}$ -in. sheet brass, equally spaced holes $1\frac{1}{8}$ in. from its center. This piece is sweated to *A*, as shown in the diagram, the $\frac{1}{4}$ -in. holes, of course, being in line.

C is a curtain-rod end. Attached to *C* is the index spring *M* that revolves over the index circle *B*. The square hole fits over the square end of the spindle *L*. *D* is another curtain-rod

How to
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ural
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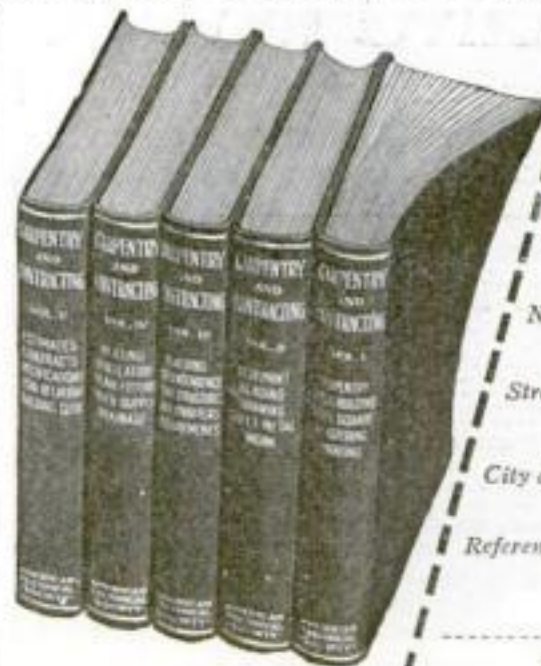
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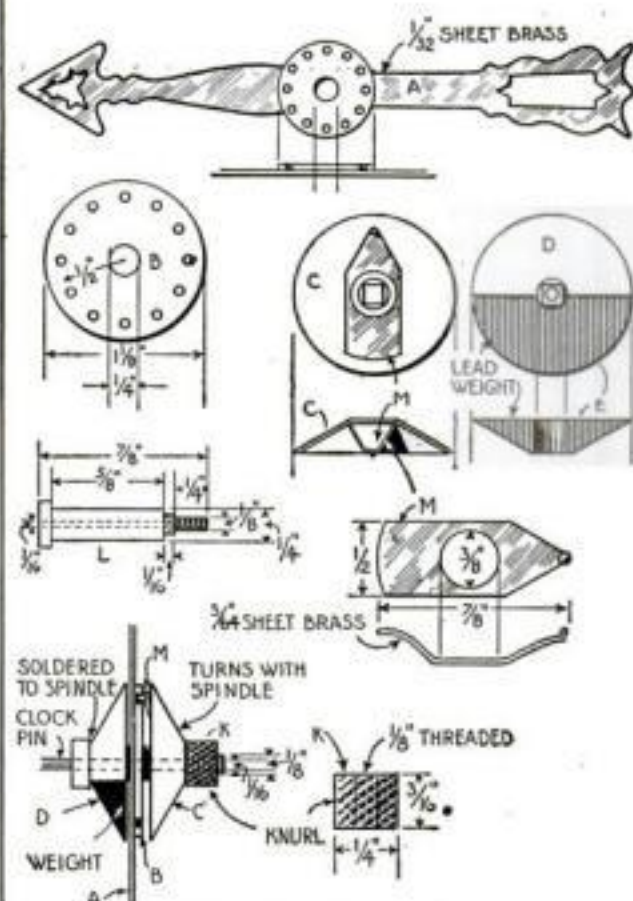
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that contains the lead weight *E* held therein by shellac. *D* is soldered to the spindle *L*. *E* is the lead weight, this being made by first filling *D* with hot lead, which is removed and sawed in half after it has cooled. *K* is the knurled nut that holds *C* and *D* together on the pointer. *L* is the spindle made from $\frac{3}{8}$ -in. drill rod with



By carefully following the above diagram and the description in this article the clock dial and pointer can be easily made from odds and ends

a $\frac{1}{16}$ -in. hole in it that fits freely over the pin in the center of the clock dial.

On *L* under the thread portion is a square part that fits into the square hole in *C*. This is necessary in order that parts *C* and *D* will turn together on the pointer *A*. *M* is a brass spring that is soldered in *C* and acts as an indicator to the performer as he feels it pass over the holes in part *B*. The dimensions given can be changed to meet individual needs.

Experimenters and amateur mechanics will get a lot of pleasure in making and using this piece of mystery apparatus.—R. S. MYERS.

A Machine that Polishes Silverware at Home

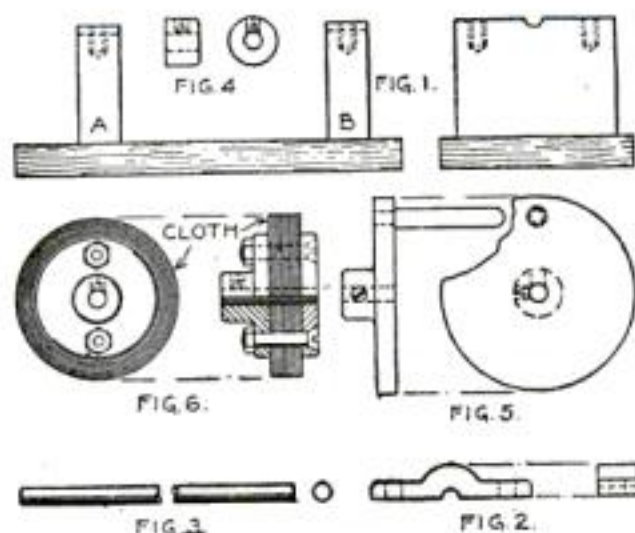
SHOULD the reader at some time or other decide that some of his household goods need a polish, why not at the same time decide to do the polishing himself?

Results make the work interesting, and to make a polishing machine good enough for such a purpose is an easy task.

The sketches accompanying this article explain fully the various parts and their functions.

First, refer to Fig. 1, which shows the base, consisting of two blocks of wood "A" and "B," each having a half hole as shown at end view. Then

comes the cap shown at Fig. 2. Of course there are two of these caps. At Fig. 3 is shown the spindle, and this is made either from a piece of

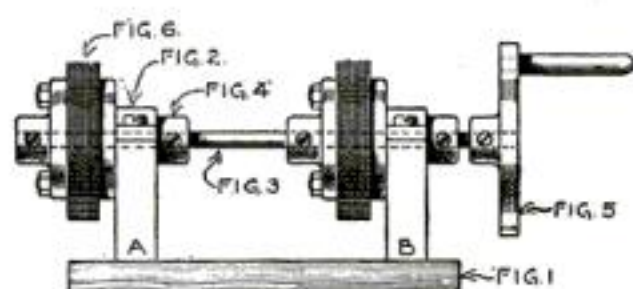


The figures in the illustrations above and below describe in detail the various parts from which the machine is made

pipe, as shown, or a piece of cold rolled steel if desired.

Four washers, as shown at Fig. 4, are used to take up the thrust of the spindle, and these can be made of wood or steel as desired.

The driving handle and disk shown at Fig. 5 does the necessary turning, and a treadle design in place of the



Silverware and brass are quickly polished with this home-made polisher

crank can be made if considerable work is to be done.

Last come the wheels. They are easily made in the manner shown at Fig. 6.

Assemble all of the parts, as shown in the lower diagram, and you have a homemade polishing-machine capable of good work.—J. W. MOORE.

Making a Wash Bottle for Test-Tube Cleaning

A WASH bottle, which is used in every chemical laboratory to clean test-tubes, can quickly be made from materials picked up about the laboratory. It consists of four parts: two lengths of glass tubing, a two-holed cork, and a bottle of any shape or size. One of the glass tubes should be from three to four inches longer than the bottle, the other about 5 in. long.

The longer tube must be bent near its top, as shown in the illustration, and the end of the shorter tube drawn out to a fine point. Both tubes are placed through the two-holed (rubber) stopper, so that the shorter tube extends about $\frac{1}{2}$ in.

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below the cork and the long tube, coming to within $\frac{1}{2}$ in. of the bottom of the bottle. Now carefully draw out the cork with the glass tubes, fill the bottle with tap or distilled water, and replace the cork.

If a current of air is blown into the short tube, a fine spray will be



Here is a quick and sure way of cleaning test-tubes. Only a few minutes are consumed in making the apparatus

ejected from the nozzle. The force of the spray is strong enough to clean the majority of test-tubes. When only a few cubic centimeters of water are required, tilt the bottle and allow the water to run out of the shorter tube.—ERNEST BADE.

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Simply run your car up to the curbing and turn the water into the radiator

side and hunt up a can (the usual way), he here has the water handy at the end of a flexible hose.

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A Tooth-Brush Makes a Good Drawing-Pen Cleaner

THERE is no better cleaner for the mechanical drawing-pen than a tooth-brush. For this purpose a ten-



A tooth-brush makes an excellent pen-cleaner, for it leaves no lint and does the job quickly and efficiently

cent one will do. The same plan applies to any kind of pen you may be cleaning.—J. W. MOORE.

How to Make a Card Dissolve into Water

A PLAYING card is taken from a deck, placed under a handkerchief, and then allowed to drop into a glass of water, where it disappears. A member of the "watch committee" performs the "dropping of the card," which adds further to the parlor mystery.

The feat is accomplished by having on the table a small piece of celluloid the exact size of a playing card. After a card has been chosen, it is placed face downward on the table, so that it will rest on top of its transparent



After placing the card beneath a handkerchief it is dropped into a glass of water, where it disappears

duplicate. Picking up celluloid and card together, they appear as one, since the face of the real card is distinctly seen through the transparent celluloid.

Under a handkerchief the real card is slipped up the performer's sleeve, while the celluloid duplicate is allowed to remain. It is this blank duplicate that the audience feel and see outlined beneath the folds of the kerchief, and of course in the water it cannot be detected.

The performer then quickly removes the card from his pocket, diverting the eyes of the spectators from the apparently empty tumbler—which can then be removed.—MERRITT HALE.

DETROIT

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Thomas Burner Co. 247 Gay St. Dayton, Ohio

Every Knock Is a Boost if You Use Your Ears

ONE of the most delicate problems the amateur motorist has to deal with is that of distinguishing between and locating various engine knocks. While there are numerous "listening" devices on the market, experience is, as usual, the best teacher, and will enable you to repair it before it develops into serious trouble. A few of the mysterious knocks are described below.

The more experience one has in listening to knocks, the more expert will one become in finding them and telling what is loose. Each faulty motor part has a different knock, which comes always in regular periods relatively to the speed of the engine.

Locating the Trouble

A loose connecting-rod produces a sharp bump or a very heavy hollow sound. It is easy to locate the faulty connecting-rod by running but one cylinder at a time, in which case two bumps are usually noticeable, due to the relief of the explosion pres-



Pull up the engine hood every so often and listen carefully. A little practice will enable you to detect trouble

sure. If the rod is very loose the knocks can be located by turning the engine with the crank. This trouble is caused by a twisted rod, loose bearing, scored bearing, burnt-out bearing, or side play. With a seized or burnt-out bearing the motor will groan or stick in starting.

The main-bearing knocks are readily located by running two cylinders at a time, one on each side of the crank bearing. A hard bump will be noticeable throughout the motor, produced regularly with the firing of the two cylinders. Such knocks are caused by end play in the shaft, loosely fitting bearings, or scored or a burnt-out bearing. In the latter two instances the motor will groan upon starting cold.

A loose piston-pin is distinguished by a sharp metallic knock. It can be located by using the listening rod for each cylinder and speeding up the motor, then closing the throttle suddenly. By doing so a double knock will be noticeable, which is very sharp and better termed a rap. The knocks

are caused by a crooked or broken pin or by a tight or badly worn member.

A loose crank-shaft is seldom encountered. It gives a rattling slap combined with a thud. In some cases only the thud is audible; in other cases the looseness of the bearings will allow the gears to slap and rattle. Generally this trouble is very hard to discover, due to the pressure of the valve springs. The trouble can be located by sounding gear-case and cam-shaft bearings with the listening apparatus. The knocks are caused by loose bearings, end play, or badly fitting bearings.

A loose flywheel will produce a very heavy knock at low engine speed, and will appear regularly. The knock will change its nature entirely when the motor is speeded up, and the vibration of the shaft will produce a dull, chattering knock. It is located by disengaging the clutch and rocking the flywheel back and forth. The trouble is caused by improper fitting, loose bolts, broken bolts, or bad keys and splines.

To Discover a Loose Piston

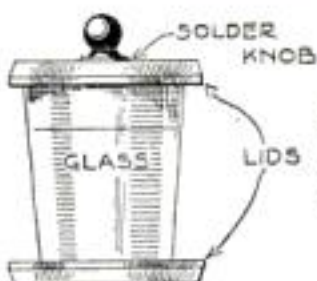
A loose piston gives a very short knock, its clearness varying with the size of the cylinder and metal used in the piston. It can be located very easily by the use of the listening apparatus against the cylinder wall. It is caused by a large bore, small piston, or taper piston or bore.

Loose valve tappets will produce a brisk tap or knock very often encountered, and difficult to remedy on a high-speed motor. This trouble is caused by an excessive clearance, bent or sticking valve stem, flat and out-of-round rollers, bent valve spring, or a seat that is not square, or a combination of causes.

Successful hunting for these troubles requires a great deal of experience that can be obtained only by continued practice, which develops the sense so that not only are the different knocks easily distinguished, but they are also speedily located.

To Make a Cover for the Medicine-Glass

TWO lids from "pry-top" cans can be put to excellent use by soldering a knob on one, as shown in the illustration, and then enameling both of them. The top with the knob acts as a dust-proof cover, while the



Make an attractive cover and tray for your drinking glass from tin can tops

other serves in the capacity of a tray to hold the glass. This is especially convenient for people who wake up in the night for a drink of water.—WILLIAM PAUL LANGREICH.

To cut down the cost per cut

Put on the Weight

If you're cutting with a medium or heavy power machine, start out with a good, full, 45-pound pressure after the first two or three strokes. As the number of cuts progresses, increase your weight. Remember that once the first keenness of the blade is gone, the heavier gauge of the blade the greater the pressure required to make the teeth "bite." Too little weight will ruin a blade almost as quickly as too much.

Follow the Starrett Hack Saw Chart in selecting your blades. Put on the weight and watch the cost per cut go down.

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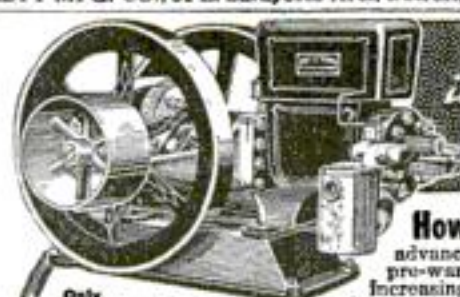
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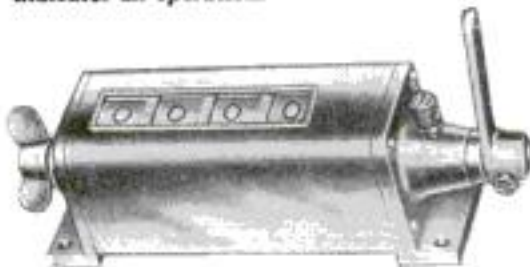
give you the right idea of what to *expect* in amount of work, and help keep up what you find to be the *standard* production-rate for each machine.

The small Revolution Counter below registers one for a revolution of a shaft, recording a machine operation. Though small, this counter is very durable; its mechanism will stand a



very high rate of speed, making it especially suitable for light, fast-running machines, and most adaptable to experimental work. If run backward, the counter subtracts. Price, \$2.00 (Cut nearly full size.)

The Set-Back Rotary Ratchet Counter below is for larger machines, such as punch presses and metal-stamping machines, where a *reciprocating* movement indicates an operation.



Registers one for each throw of the lever, and sets back to zero from any figure by turning knob once round. Supplied with from four to ten figure-wheels, as required. Price with four figures, as illustrated, \$10.50. (Cut less than 1/2 size.)

There's a Veeder for every purpose where you could possibly use a counter. Write for the new counter booklet.

The Veeder Mfg. Co.,
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Keep the Engine Clean and Prevent Fires

MOTORISTS usually pride themselves on keeping the car engine clean by giving it a bath in kerosene every so often; this is to remove the heavy grease deposits that accumulate on its exterior. To get

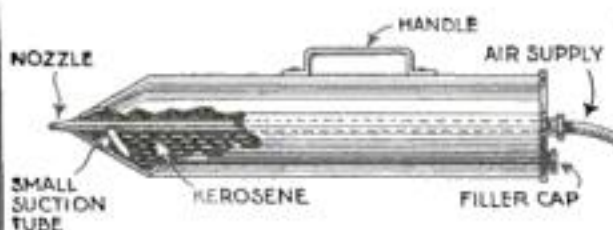


Where there are a number of automobile engines to clean, this contrivance is indispensable as both a time- and money-saver

into all the crevices, beneath the carburetor, and around the water-pump is almost impossible, for the brush used in the operation is much too large to permit this.

A gasoline or kerosene spray, under air pressure, will quickly remove grease and dirt from the engine of the chassis.

The contrivance that throws this spray is shown in the illustration,



As shown by the diagram, the cleaner is extremely easy and simple to make

being made at practically no cost, and will prove its weight in gold to the man who has much of this work to do.

A tank holds the liquid, and an aspirator is used for forming the spray. The aspirator is nothing more than a copper pipe which passes through the center of the tank, one end being connected to the air pressure line, and the other end being drawn down into a nozzle. A small copper tube connects this pipe, so that the cleaning solution is drawn from the tank and forced into a spray by the passing air. A foot pump can be used to inject air if no other pressure is available.

The foregoing proves that this cleaner is practical for quick work in either the public or home garage. It can be stowed away when not in use.—R. L. PRINDLE.

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How to Turn Accurate Gage Pieces

IN some kinds of work it is necessary to use accurate cylindrical pieces as gages for setting up parts in alinement. Since these pieces are of special sizes and often used only once or twice, grinding or other expensive methods of making could not be considered.

If a piece is ordinarily turned in a lathe by using a dog on either end,



How to eliminate expensive methods and still be able to turn out accurate gage pieces

chucking one end, etc., certain small inaccuracies are bound to result. Accordingly, drill a hole in one end and force a pin in it to act as a dog. In this manner the piece is produced entirely on center and at one setting, besides resulting in absolute accuracy.—S. B. ROYAL.

A One-Man Sack-Filling Contrivance

THIS device for holding sacks while filling them should save backache and many useless adjectives.

It is made of half a pickle-barrel with the ends knocked out, attached by a small block of wood to the side of a bin or granary.

Five or six nails, driven through the sides of the barrel from the inside and pointing at an upward angle when the



With this arrangement for holding the sack, one man can do the work of two in filling

barrel is in place, hold the sack in place during the filling. The sack is pulled up over the bottom of the barrel as shown. It should be at the right height from the floor for filling, at the same time resting on the floor to prevent strain on the nails and tearing the sack.—DALE VAN HORN.



"Son, this saw is part of your education—



"It will give you the practical experience you need to develop the talent that's in you.

"Another thing, son—this saw is balanced, sharpened and set as accurately as a delicate instrument is adjusted. And with proper care it will stay that way.

"A Disston Saw holds its set and cutting edge under all working conditions. That's because it's made of Disston Crucible Steel, tempered and hardened to meet exactly the requirements of hand saws."

A Disston Saw develops initiative, resourcefulness, and creative ability. It cuts so clean, so fast, so true that its use is a constant inspiration toward good work.

Disston Hand Saws are made in various styles—a saw to meet each specific requirement. Sold by dependable dealers everywhere.

Write for the Disston Booklet on Saws—it tells how to select, use, and care for Disston Saws and Tools.

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Red Devil PLIERS

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This Wire Swing Will Last for Years

WHEN the ordinary swing is made from rope and attached to the limb of a tree or some other high support, it will be noticed that the seat sometimes is high and at other times very low. This is due to atmospheric conditions.

A fine substitute for the rope is a galvanized wire, such as is used by linemen for guying-poles. This, however, cannot be wrapped around the tree limb like a rope, as the constant



The wire swing is not affected by atmospheric conditions as is the old-time rope swing

bending back and forth would soon break it off.

Obtain a pair of heavy barn-door hinges; fasten one end to the tree, then attach the wire to the other end of the hinges, as shown in the illustration. An occasional oiling or greasing will make the swing last for years and withstand the elements as a rope swing would not.—VICTOR H. TODD.

An Automatic Drinking-Cup for Poultry

FIVE or six times a day the pail containing the chickens' drinking water must be refilled. But why not simplify the task and supply the drinking water from a reservoir that automatically regulates the flow of water?

This automatic drinking-cup consists of three simple parts: a small but deep enamel dish, a bottle, and a support. The support consists of a board 8 in. wide and one third longer than the bottle. The lower part of the board receives a small shelf slightly larger than the cup that is placed upon it. Then the bottle is laid upon the board and two strips of tin are so nailed to it that they will hold the bottle in the position shown in the photograph. The support can now be attached to the chicken-house,

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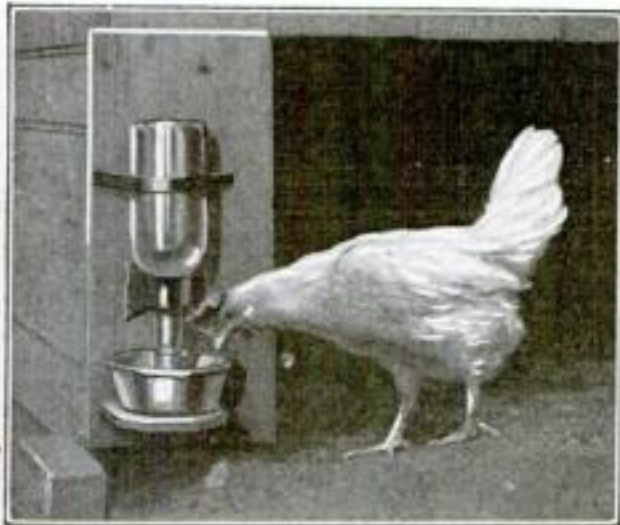
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the cup being two or three inches above the ground.

When the bottle has been filled with water it is quickly inverted over the cup. Water will run out of the bottle



If you use this contrivance in the hen-yard your poultry will never be thirsty; it refills automatically.

until the surface just touches the neck. The water used is replaced by fresh water running out of the bottle. The bottle need be refilled only when it is empty.

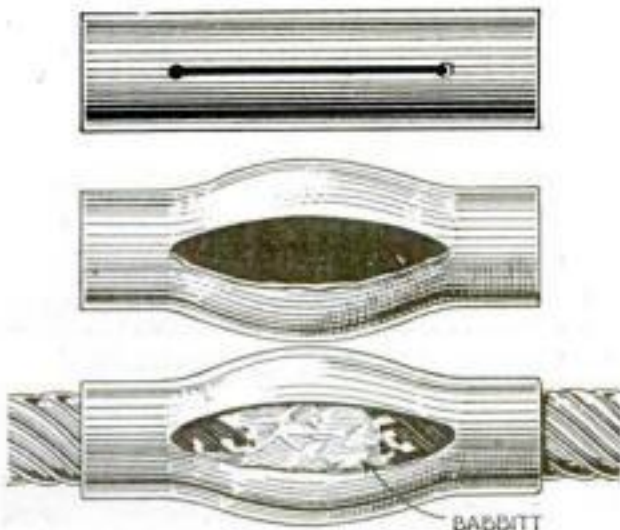
As can be seen from the illustration, the chicken cannot stand upon the water-pan and overturn it, for it is set against its stand in such a way as to prevent this.—ERNEST BADE.

How to Install a Cable on an Elevator

WHILE installing a new operating cable on an elevator, I found that a short piece had been spliced in and had simply been tied in several bulky knots.

Slipshod work of this kind is the reason why many accidents happen in the large mills and factories throughout the country.

A better and more workmanlike way to do this job would have been to use a piece of pipe about 8 in. long and

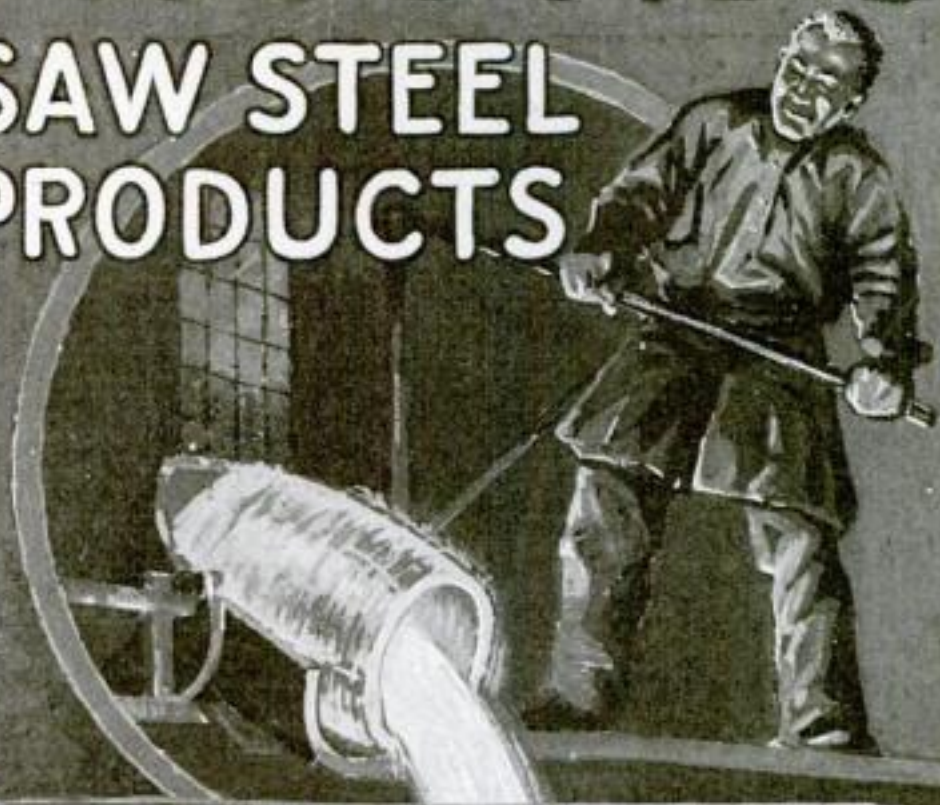


Make a neat splice in the elevator cable in the manner here indicated

of a diameter large enough to allow the cable to enter easily. Slit the pipe for about 4 in., and spread the halves with a chisel, as shown in the illustration. Place the ends of the cable in the ends of the pipe, spread the strands, pour in hot babbitt and the job is finished.—ERNEST SCHWARTZ.

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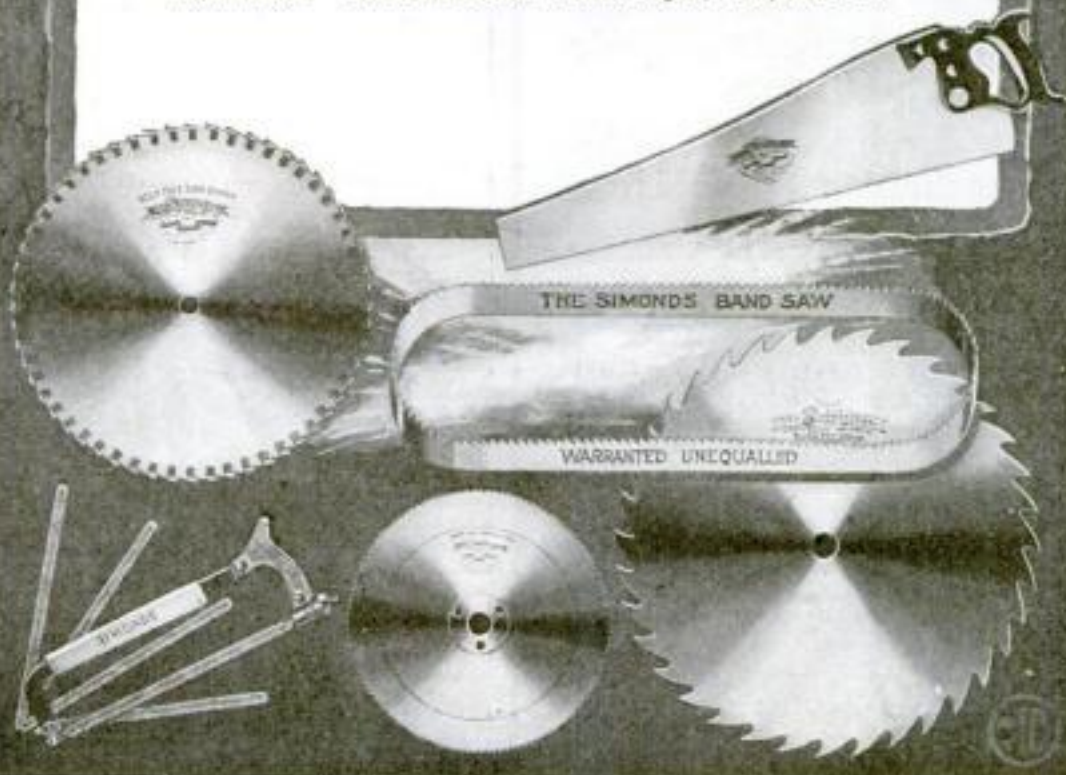
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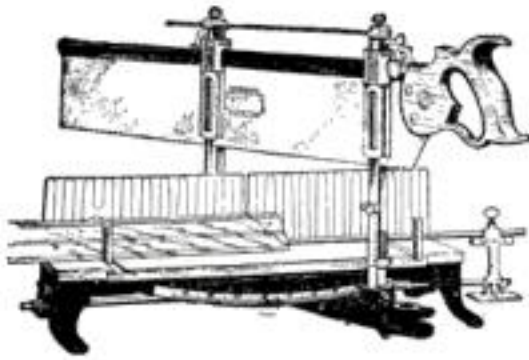
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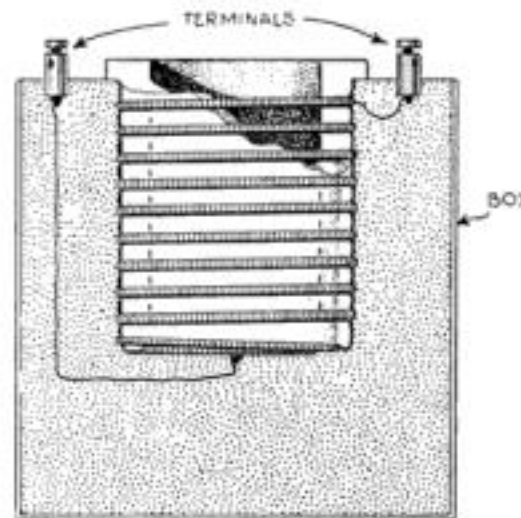
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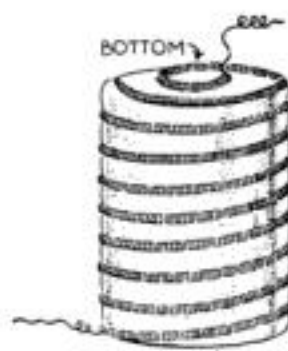


A cutaway view of the electric furnace—a contrivance that will be a valuable addition to any laboratory

will be found exceedingly useful in the laboratory. To make it, secure a corrugated Alundum core $2\frac{1}{2}$ in. deep and 2 in. in diameter. Hollow cores, open at one end and closed at the other, can be obtained for this purpose.

Next, wind as closely as possible 42 ft. of bare No. 20 resistance wire on a spindle $\frac{3}{32}$ in. in diameter, leaving one ft. free at each end for connections. This will be better if machine-wound. When the coil has set, stretch it slightly so that the turns will not touch, and, starting with one end at the center of the grooves on the bottom of the core, wind it about the cylinder and secure it in position temporarily with cord. Cover the whole with a layer of Alundum cement to a depth of $\frac{1}{8}$ in., and connect directly to a 110-volt lighting circuit. The heat developed will very quickly cause the cement to set.

Now, for prevention of heat losses and greater convenience in use, insulate this unit with a mixture of fire-clay, asbestos fiber, and water-glass as follows: Secure or make a cubical box about 5 in. on an edge, and pack in the bottom of it a doughy mass of the above mixture, using water-glass in the form of a solution. Set the heating unit in the center and just flush with the top, bringing the free ends of



OPEN END
The wire is wound as closely as possible on the spindle

the wire out for connections. Then pack the mixture about it firmly, making a smooth, even surface on the top. Make a tightly fitting cover of the same material, and fill the cavities of both with a cement of fire-clay and water-glass. With the cover in place, turn on the current, and when thoroughly dry and hardened break

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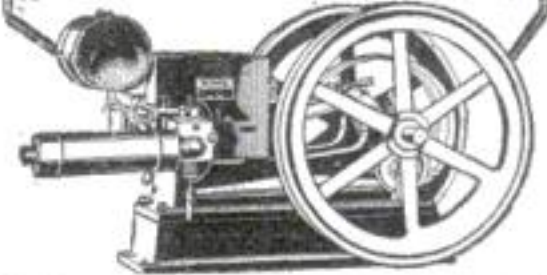
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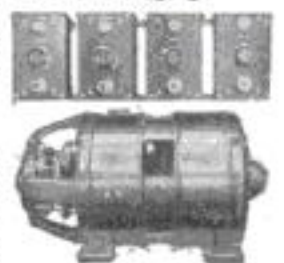
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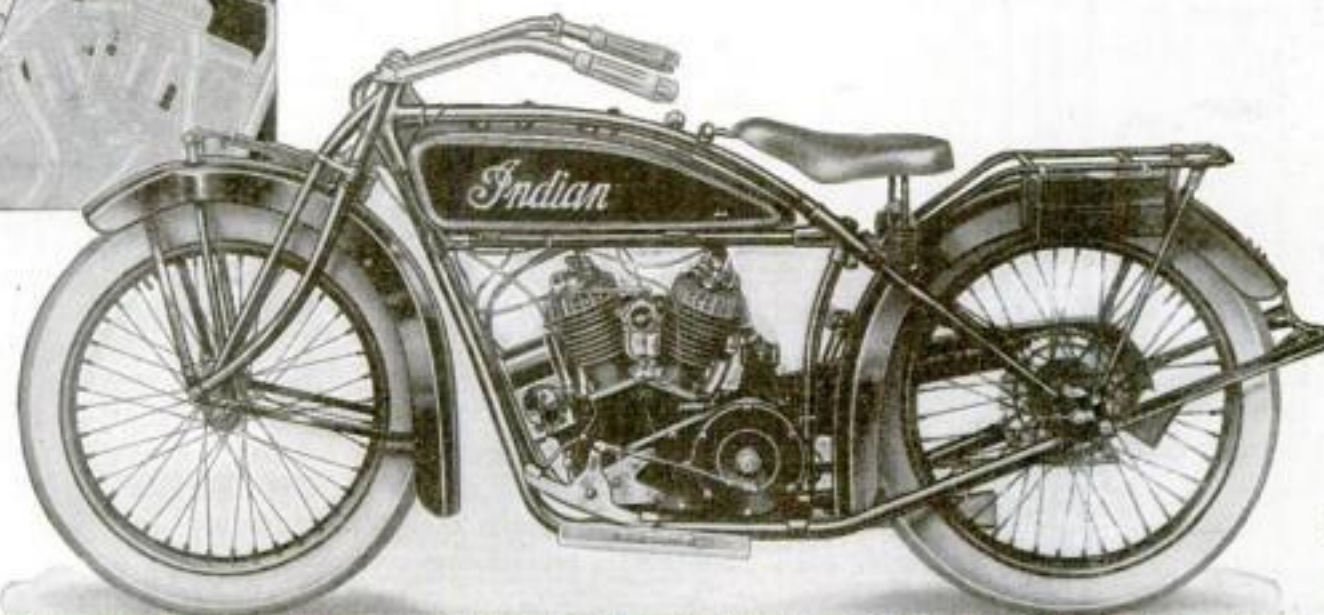
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away the box and retouch the surface with the fire-clay and water-glass cement. The ends of the wire may be secured to binding-posts set in the cement, if desired.

Such a furnace as this may be made at very small cost, and it will serve as well as a bought furnace for which you would pay a considerable sum. In it precipitates may be ignited, fusions made, and alloys melted. It will give a temperature of 1,000° C. for an indefinite period or 1,200° C. for a short time. By means of a suitable resistance in series with the furnace any desired temperature may be obtained, and for prolonged use such a resistance will be essential. The capacity of the furnace is such that it will take crucibles of several sizes.—FLOYD L. DARROW.

Separating Water from Oil by Filtration

TO separate large quantities of water from oil, first let the liquid stand for twenty-four hours, at the end of which time all the oil will be floating on top, and then use a separatory funnel. If the oil and the water



Here is the way to separate oil from water. A funnel, filter paper and a container are all that is necessary.

do not separate easily, a few cubic centimeters of benzol stirred into the liquid will accomplish your object. The benzol can be removed by distilling over a water bath.

Sometimes, when there is only a small quantity of water intimately mixed with the oil, the water and oil will not separate, no matter how long the liquid is left standing. In such cases water must be removed by filtration. The filter paper is placed in the funnel in the usual way, and the paper is filled with common table salt. Now the liquid is poured on the salt until all of the oil has filtered. The salt is not dissolved by the oil, and there is not enough moisture present in such a solution to dissolve it, but it absorbs the moisture and allows the oil to drain through thoroughly dry.—ERNEST BADE.

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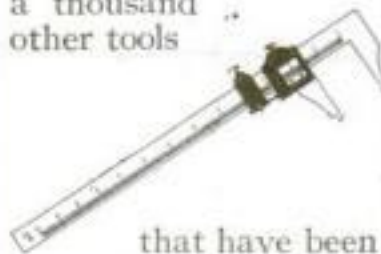


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The Ultona

vents the sound waves from expanding properly. Thus, we overcame the old-time harshness.

With these two inventions the Brunswick Method of Reproduction brings a phonograph the like of which cannot be equaled in versatility nor tone. All we ask to prove it is that you hear The Brunswick. Compare it with others. Your own ear will decide.

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The Brunswick Tone Amplifier



Brunswick Records

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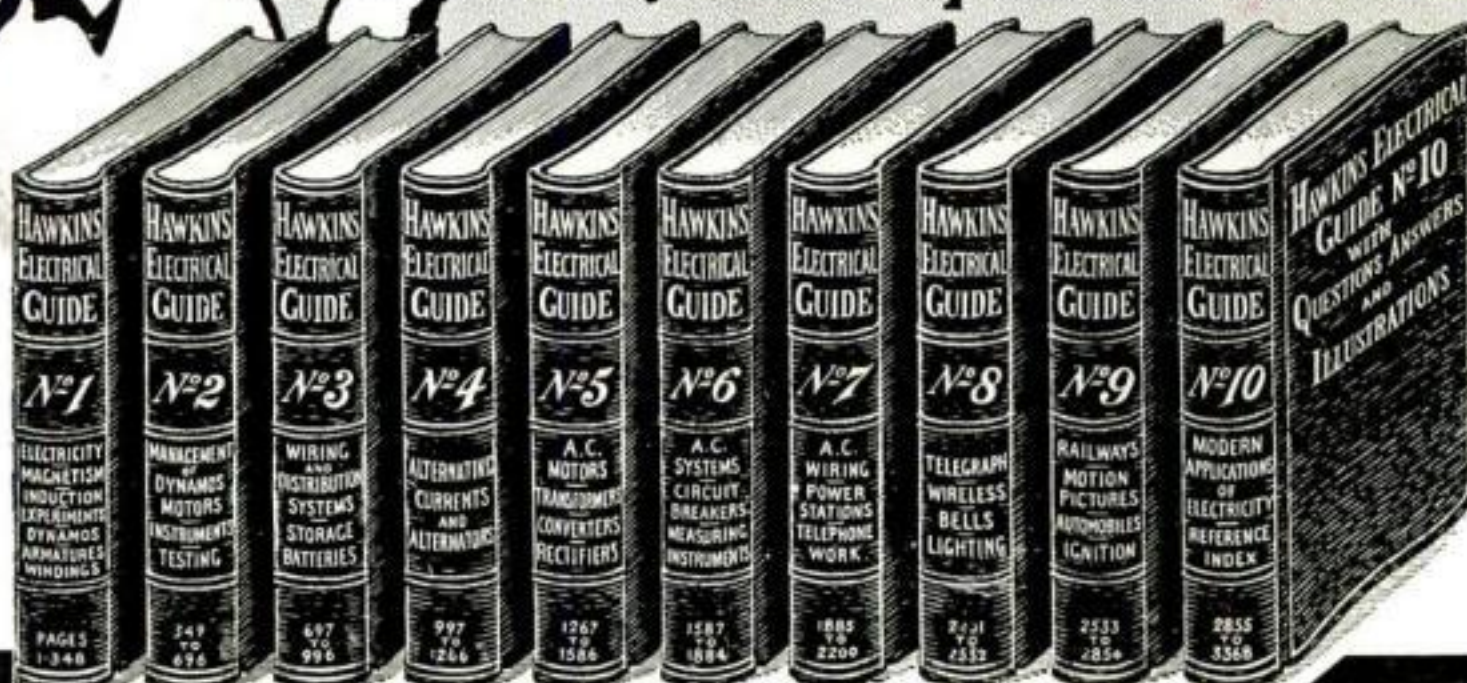
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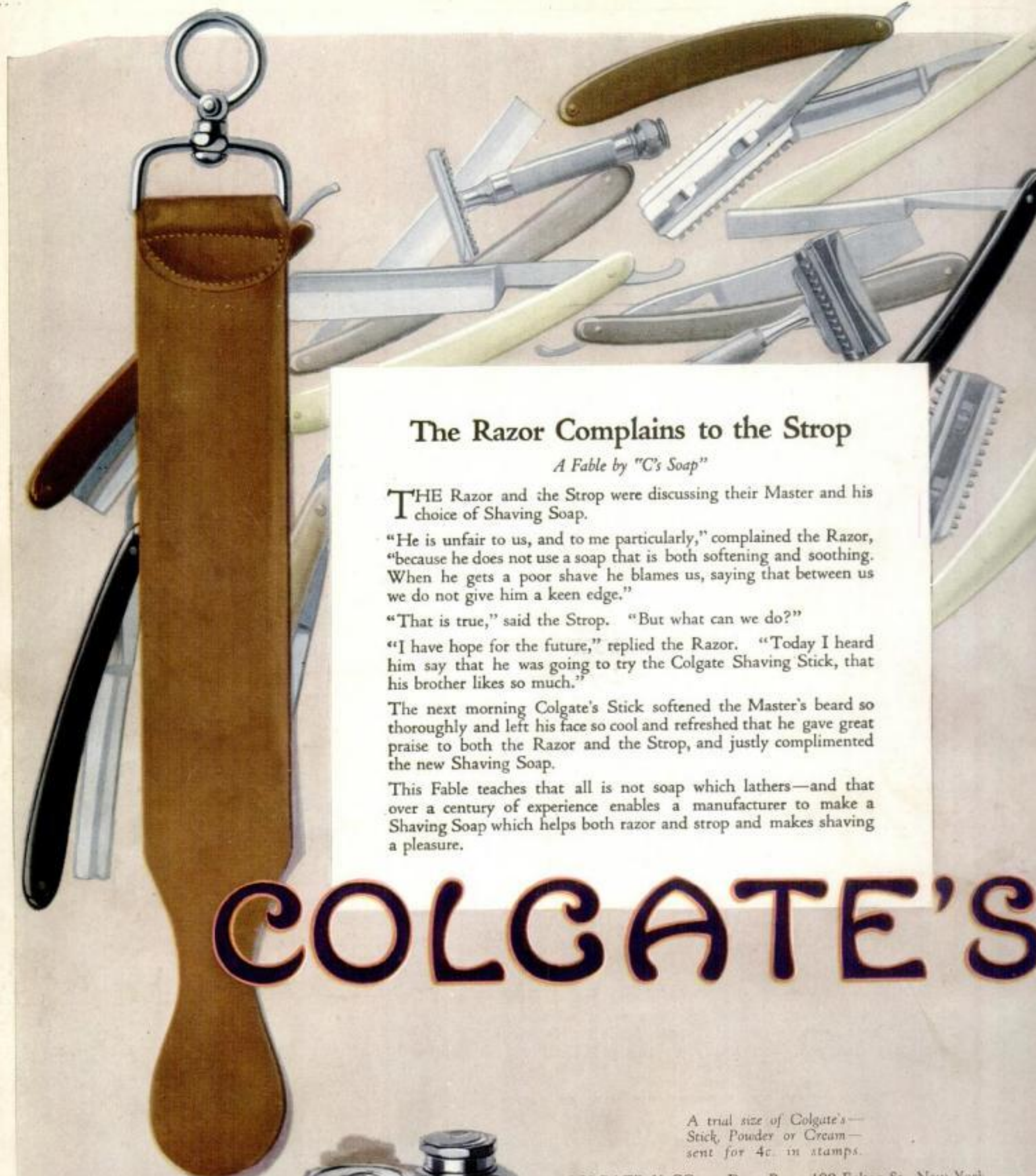
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